SEP 15 1926

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The Engineer.

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VOL. CXLII.—No. 3686] LONDON: FRIDAY EVENING, SEPTEMBER 3, 1926 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

Ministry of Transport.

WIDENING OF SANDY-LANE, WALLINGTON, SURREY.

The Minister is prepared to receive TENDERS for WIDENING a SECTION of SANDY-LANE, WALLINGTON, SURREY, approximately 1650ft. in length, and certain contingent WORKS in the forecourts of the premises abutting thereon.

Form and conditions of Tender, form and conditions of contract, bill of quantities and specification may be obtained from, and the drawings inspected at, the office of the Divisional Road Engineer (London Division), Ministry of Transport, 7, Whitehall-gardens, S.W. 1, upon payment of a deposit of £10. A copy of the drawings may also be inspected at the office of the Resident Engineer at the site of the work.

The deposit will be returned to the tenderer if his Tender is a bona fide one, and has not been withdrawn prior to the definite acceptance of a Tender by the Minister.

Tenders, on the official form, accompanied by a fully priced bill of quantities and enclosed in a sealed envelope, endorsed "Tender for Widening of Sandy-lane, Wallington, Surrey," must reach the Assistant Secretary, Roads Department, Ministry of Transport, by 10 a.m. on the 20th September, 1926.

The Minister does not bind himself to accept the lowest or any Tender.

Dated this first day of September, 1926.

E. W. ROWNTREE,
Assistant Secretary.

Ministry of Transport,
Whitehall-gardens, S.W. 1. 3464

HEATING.

The Commissioners of

His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Friday, 17th September, 1926, for ACCELERATED LOW-PRESSURE HOT WATER HEATING at Maidstone Post Office, &c.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners of His Majesty's Works, &c.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 3446

The Director - General,

India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for—

16 GOODS BRAKE VANS.

Tenders due on the 17th September, 1926. Specifications and forms of Tender obtainable from the above at a fee of 5s. per set, which will not be returnable. 3468

Assistant Engineer Required

by the GOVERNMENT of the GOLD COAST for the CAPE COAST WATER SUPPLY for a tour of 12 to 18 months' service, with possible extension. Salary £480, rising to £920 a year. Free quarters and passages and liberal leave on full salary. Outfit allowance of £60 on first appointment. Candidates, aged 25 to 35, must have passed examination to qualify for A.M.I.C.E. or hold equivalent professional qualifications and have had experience in maintenance and construction on a recognised railway in the United Kingdom or a British Colony. A good knowledge of surveying is essential.—Apply at once by letter, stating age and particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/14790. 3451

Civil Engineer Required

by the GOVERNMENT of the GOLD COAST for the CAPE COAST WATER SUPPLY for a tour of 12 to 18 months' service, with possible extension. Salary £480, rising to £920 a year. Free quarters and passages and liberal leave on full salary. Outfit allowance of £60 on first appointment. Candidates, aged 25 to 35, should be fully trained Civil Engineers, preferably A.M.I.C.E., who have had experience in waterworks construction and pipe laying.—Apply at once by letter, stating age, qualifications and particulars of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/14645. 3471

Civil Engineers (2)

REQUIRED by the RAILWAY DEPARTMENT of the TANGANYIKA TERRITORY for a tour of 30 to 36 months' service, with possible extension. Salary £480 to £720 a year. Outfit allowance of £30 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 23 to 40, must be fully qualified Railway Engineers who have had good training and experience on recognised European, American or colonial railways. Candidates who are A.M.I.C.E. preferred.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14544. 3450

City of Cardiff Education

COMMITTEE.

THE TECHNICAL COLLEGE.

Principal: CHARLES COLES, B.Sc. (Lond.).

DEPARTMENT OF ENGINEERING.

Head of Department: A. W. LOVERIDGE, B.Sc. (Eng.), A.R.C.Sc.

SESSION 1926-7.

Commencing on Tuesday, 5th October, 1926.

The following Courses have been arranged for Engineering Students:—

A Three Years' Course in Mechanical and Marine Engineering jointly with the University College of South Wales and Monmouthshire.

A Two Years' Course for Apprentices and others with facilities for practical experience in the Summer Term.

These Courses are suitable for students preparing for Degrees in Engineering or for the Examinations of the Engineering Societies.

Special Courses are also arranged for Marine Engineers preparing for the Examinations of the Board of Trade.

OPEN SCHOLARSHIPS, covering tuition fees and maintenance grants of £40 per annum for three years, are offered for competition annually and candidates for entry to the above Department are eligible to compete.

For further particulars of Full-time and Part-time Courses, Entrance Examination, Scholarships, Fees, &c., apply to the Principal. Application forms for Entrance Scholarship Examination, duly filled up, must be received before September 18th.

JOHN J. JACKSON,
Director of Education.

City Hall, Cardiff. 3195

The Engineer

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PUBLIC NOTICES

Northampton Polytechnic

INSTITUTE.
St. John-street, London, E.C. 1.
SESSION 1926-7.

ENGINEERING DAY COLLEGE.

The College provides courses in Civil, Mechanical, Electrical, Aeronautical, and Radio Engineering.

Each course occupies four years and includes provision for students to spend two summer periods, April to September, in commercial works.

Matriculated students are able to enter as Internal Candidates for the examinations leading to Degrees in Engineering of the University of London.

Students should be not less than sixteen years of age at entrance.

An entrance examination in English and Mathematics will be held on Thursday and Friday, September 9th and 10th. Classes commence Monday, September 27th.

TUITION FEES.—£18 per annum for students residing in London, Kent or Middlesex; £20 for students resident elsewhere.

Three entrance scholarships, each of the value of £18 per annum, are offered for competition at the entrance examination.

A prospectus giving full particulars will be forwarded on application to the PRINCIPAL. 3137

Northampton Polytechnic

INSTITUTE,
ST. JOHN-STREET, E.C. 1.

Evening Courses in ENGINEERING and in FUEL TECHNOLOGY and METALLURGY (including Metallography) for Engineers, Engineering Chemists, &c., commence on Monday, September 20th, 1926.—Prospectuses may be obtained from the PRINCIPAL. 3158

University of St. Andrews.

LECTURESHIP IN MECHANICAL ENGINEERING AND MACHINE DESIGN IN UNIVERSITY COLLEGE, DUNDEE.

The University Court of the University of St. Andrews invite APPLICATIONS for the VACANT LECTURESHIP in MECHANICAL ENGINEERING and MACHINE DESIGN with special qualifications in Thermodynamics and Heat Engines, in University College, Dundee. The Lecturer to be appointed will enter upon his duties as at 1st October, 1926. Further particulars will be furnished by the undersigned. Twenty printed or typewritten copies of the letter of application and relative testimonials should be lodged with the undersigned on or before September 10th. Candidates are requested to submit at least three testimonials, or, alternatively, to furnish the names of three referees.

ANDREW BENNETT,
Secretary and Registrar.

The University, St. Andrews,
August, 1926. 3437

PUBLIC NOTICES

The Polytechnic, 309, Regent

STREET, W. 1.

STUDENTSHIP EXAMINATION OF THE INSTITUTION MECHANICAL ENGINEERS.

PRELIMINARY EXAMINATION, INSTITUTION OF CIVIL ENGINEERS.

FINAL EXAMINATION, INSTITUTION ELECTRICAL ENGINEERS (PART 1).

Special Courses have been arranged for Students taking the above Examinations. The syllabus covers all the work in PURE MATHEMATICS, MECHANICS, PHYSICS, ENGLISH and FRENCH.

Fee for the Course, £2 2s.

Prospectus free on application to the DIRECTOR OF EDUCATION. 3189

The Royal Technical College,

GLASGOW.

DEPARTMENTS OF ENGINEERING.

MECHANICS AND MECHANICAL ENGINEERING:
Professor ALEXANDER L. MELLANBY, D.Sc., M.I. Mech. E.
Associate Professor WILLIAM KERR, Ph.D., A.R.T.C.

ELECTRICAL ENGINEERING:
Professor STANLEY PARKER SMITH, D.Sc., M.I.E.E., A.M. Inst. C.E.

CIVIL ENGINEERING:
Professor GEORGE MONCUR, B.Sc., M. Inst. C.E., M. Amer. Soc. C.E.

MINING ENGINEERING:
Professor DANIEL BURNS, M. Inst. M.E.

CHEMICAL ENGINEERING:
Professor of Technical Chemistry: THOMAS GRAY, D.Sc., LL.D., Ph.D., F.I.C.

Complete Courses of Instruction are provided, qualifying for the Diploma of the College and for the Degree of B.Sc. in Engineering of Glasgow University.

Composition fee 25 guineas per annum.

SESSION 1926-7 BEGINS on TUESDAY, SEPTEMBER 21st.

Calendar, by post, 3s., and prospectus, gratis, may be obtained on application to the DIRECTOR. 2848

COUNTY BOROUGH OF WEST HAM.

West Ham Municipal College,

SESSION 1926-27.

DAY and EVENING COURSES in CIVIL, MECHANICAL and ELECTRICAL ENGINEERING, under recognised teachers of London University.

Matriculated Students are recognised as "Internal" Students of the University.

Enrolment of students, September 13th to 17th.

Particulars of these and other courses in the prospectus to be obtained from the Principal.

GEORGE E. HILLEARY,
Town Clerk.

18th August, 1926. 3139

PUBLIC NOTICES

Crystal Palace School of

PRACTICAL ENGINEERING.
Founded 1872.

Principal: MAURICE WILSON, M. Inst. C.E., F.S.E.
Vice-Principal: F. C. P. LAWRENCE, M.S.E., A.M. Inst. Struct. E.

The NEW SESSION will COMMENCE on SEPT. 15th. 3434

University of Manchester.

PHYSICS DEPARTMENT.

Full particulars of the LECTURES and LABORATORY COURSES in PHYSICS, preparing for both the Ordinary and the Honours Degrees, will be forwarded on application to the REGISTRAR. 3129

The University of Sheffield.

SESSION 1926-27.

Vice-Chancellor: SIR HENRY HADOW, C.B.E., D.Mus., LL.D.

DEPARTMENTS OF MECHANICAL, ELECTRICAL, AND CIVIL ENGINEERING METALLURGY, MINING, FUEL TECHNOLOGY, AND GLASS TECHNOLOGY.

The Courses in the above Departments extend over three or four years and prepare students to become specialists in one or other of these branches of Applied Science.

The LECTURE COURSES in all the Departments are supplemented by Practical Training in Laboratories and Workshops, which are fully equipped for the purpose of advanced scientific teaching, investigation and research.

Part-time Courses are arranged for students who desire to take special portions of any of the regular Courses.

In Mining Engineering and in certain of the Courses in Mechanical and Electrical Engineering, and in Glass Technology, arrangements are made to enable students who come to the University from works or collieries to take six months' Courses of study at the University and six months' practice at the works or colliery each year for a period of four years. During the first year such students should spend three terms at the University.

The LECTURE COURSES commence OCTOBER 6th, 1926.

The TECHNICAL LABORATORY COURSES commence SEPTEMBER 28th, 1926.

For further details of the Courses and for particulars of the Degrees, Associateships, Diplomas, and Certificates awarded on their successful completion, application should be made to

W. M. GIBBONS,
3023 Registrar.

The Institution of Structural

ENGINEERS.

MODIFIED EXAMINATION FOR ASSOCIATE-MEMBERSHIP.

A MODIFIED EXAMINATION for ASSOCIATE-MEMBERSHIP for candidates of and over 25 years of age who have at least 10 years' experience (including time served in apprenticeship or articles) is HELD QUARTERLY. It consists of an examination in Design worked privately by the candidate in the course of his practice at home. The NEXT EXAMINATION will take place on 18th SEPTEMBER (papers posted on the 17th), and entries must be in by 13th September. Syllabus and full particulars from the undersigned.

MAURICE G. KIDDY,
Secretary of the Institution.

10, Upper Belgrave-street, S.W. 1. 3135

The Directors of the Great

Southern Railways offer FOR SALE GAS PRODUCER PLANT as follows:—

ONE OPEN-HEARTH ANTHRACITE GAS PLANT of capacity 106 B.H.P., complete with Scrubber, Vaporiser and Starting Fan. Type "D" No. G. 5309. Makers, Crossley Bros., Manchester. Erected in 1923.

ONE CROSSLEY HORIZONTAL GAS ENGINE, Type "Y," capable of developing 74 B.H.P. when working with producer gas of 140 B.T.U. per c. ft. Complete with Cooling Tank, Silencer and Town Gas Starter with Magneto Ignition. Erected in 1923.

Form of Tender (on which alone offers will be considered) may be had on application to the Stores Superintendent, Inchicore, Dublin, and the plant may be inspected by prospective tenderers at the Company's Works, Broadstone, Dublin.

Tenders should be forwarded so as to reach the undersigned not later than 10 a.m. on Thursday, the 23rd September, 1926, in the envelope provided for the purpose.

The Directors do not bind themselves to accept the highest or any Tender.

C. E. RILEY,
Secretary.

Kingsbridge Station, Dublin,
September, 1926. 3441

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PUBLIC NOTICES

County of London.

The London County Council invites APPLICATIONS for the POSITION of ELECTRICAL ENGINEER in its Tramways Department.

The salary will be £1200 a year, rising by annual increments of £50 to a maximum of £1500 a year. The salaries mentioned are based on pre-war conditions and are subject at present to temporary additions on the Civil Service scale, fluctuating according to the cost of living. The total commencing remuneration on the existing basis is £1404 15s. 10d. a year, but the temporary additions will be revised not later than 1st March, 1927.

Candidates must be qualified electrical engineers, accustomed to a position of superior responsibility in an electrical power undertaking, and experienced in the design, construction, &c., of generation and distribution plant and equipment, and the organisation and control of a large staff. The age of candidates must not exceed 50 years on the latest date for the receipt of applications. Preference will be given to candidates who served or attempted to serve with H.M. Forces during the Great War.

Applications must be on forms (containing full details) to be obtained from the Clerk of the Council, The County Hall, Westminster Bridge, S.E. 1 (stamped addressed foolscap envelope necessary). Forms must be returned so as to be received not later than Tuesday, 5th October, 1926. Canvassing disqualifies.

MONTAGU H. COX,
Clerk of the London County Council.

3186

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, INSPECTOR for WATERWORKS. Able to do repairs in emergency. House provided. State age, experience, and wages required.—CHILTERN HILLS SPRING WATER CO., Aylesbury, Bucks. P2229 A

WANTED, MINING ASSISTANT to the General Manager of an Opencast and Underground Iron Ore Property in the East. Candidates should have had previous practical experience, and a sound technical education. Applicants to give details of past experience and other qualifications, with references, and state salary required. Furnished single quarters are provided, and the employee receives an allowance sufficient to cover the cost of living at the mine.—Address, 3454, The Engineer Office. 3454 A

WANTED, Thoroughly Experienced MOTOR MECHANIC, to Take Charge of Garage Workshop. Must be used to all cars and able to undertake all repairs. Applicants only with these qualifications will be considered. Bedfordshire.—Address, 3462, The Engineer Office. 3462 A

AN OPENING OCCURS to Take ACTIVE WORKING INTEREST in young FIRM (London) manufacturing Fuel Economy Apparatus. Intimate knowledge of Power Plants and D.O. experience essential. Small capital interest offered after trial. State age, past experience, min. salary at start, when free. Principals only.—Address, P2220, The Engineer Office. P2220 A

APPLICATIONS are INVITED for the POSITION of CHIEF INSPECTOR accustomed to High-grade Machine-cut Gearing. Must have organising ability and be familiar with systematic and up-to-date methods of handling quantity production expeditiously.—Apply, stating age, salary required, and full particulars of qualifications and experience, to DAVID BROWN and SONS (HUDDFD.), Ltd., Park Works, Lockwood, Huddersfield. 3442 A

ASSISTANT MANAGER WANTED by Marine Engineers, Dry Dock Owners and Ship Repairers in China. Aged about 35.—Address, detailing experience and qualifications for this position, P2221, The Engineer Office. P2221 A

ELECTRICAL MECHANICAL ENGINEER, Sao Paulo, South America, eighteen months' contract. Erection and working of High-tension Switchgear, Converting Plant, A.C. and D.C. Low-tension Distribution. Only men with practical working steel works or colliery experience considered.—Applications, stating age, experience, salary required, and copies of three recent testimonials, to BRAITHWAITE and CO., ENGINEERS, Ltd., West Bromwich. 3444 A

ESTIMATING ENGINEER REQUIRED. Fully conversant with Stationary and Marine Oil Engines and with some commercial training.—Apply by letter, stating age, qualifications, references, and salary required, to ATLAS DIESEL CO., Ltd., 35, Surrey-street, Strand, London, W.C. 2. 3432 A

LONDON CONSTRUCTIONAL ENGINEERS REQUIRE ASSISTANT in Designing Department. Able to prepare good designs economically and rapidly. Experience of London buildings essential. Particulars of experience, age, salary, &c.—Address, 3461, The Engineer Office. 3461 A

POWER ENGINEER REQUIRED by Manufacturing Firm in North-East London. Experience with Babcock and Wilcox Boilers essential. Salary £400 to £450.—Apply by letter, stating age, qualifications and experience, P2228, The Engineer Office. P2228 A

SALESMAN.—JUNIOR REQUIRED in London by a Firm specialising in Boiler-house Control Apparatus. Salesmanship rather than sound engineering knowledge the leading qualification. Age limit 26. Unmarried preferred. Excellent opening for a gentleman with public school education and a natural aptitude for the post. Give full particulars of experience, knowledge, and salary required.—Address, 3460, The Engineer Office. 3460 A

SALES ORGANISATION.—DISTRICT REPRESENTATIVES WANTED to Sell first-class Lubricating Oils and Greases and to Obtain and Supervise Travellers for certain prescribed areas. Would suit firms having sales organisation in other non-competitive lines. Mutual terms.—Address, 3463, The Engineer Office. 3463 A

REINFORCED CONCRETE ENGINEER and DESIGNER, experienced in all classes of Reinforced Concrete Structures.—Apply, giving full particulars and stating salary required, to F.C. CONSTRUCTION CO., Ltd., 26, Irongate, Derby. 3429 A

WELL-EDUCATED YOUTH REQUIRED by Agent representing leading Engineering, Metal and Hardware Firms. Good prospects and opportunity of learning the trade. Small commencing salary and small premium required.—Reply in writing to BALDWIN, 43, Cannon-street, E.C. 4. P2209 A

WANTED, a JIG and TOOL DRAUGHTSMAN, familiar with High-class Machine-cut Gear Production and accustomed to high-class quantity production.—Apply, stating full qualifications, experience, age, and salary required, to DAVID BROWN and SONS (HUDDFD.), Ltd., Park Works, Lockwood, Huddersfield. 3443 A

WANTED, a Thoroughly Efficient and Capable DRAUGHTSMAN (temporary), to Design a Factory and Stores; only those used to North Light Roof Construction need apply. Six months' work guaranteed.—Apply by letter, giving full particulars as to references, &c., and salary required, to the ENGINEER, Gasworks, Waddon, Croydon. P2212 A

WANTED, Quick and Accurate ESTIMATING DRAUGHTSMAN; must be well acquainted with latest design and current prices for modern Elevating and Conveying Plants as used in Boiler-houses, Steel Works, Quarries, and also with General Light Conveying Work, Bunkers, Structure, &c. Midlands district.—Address, 3436, The Engineer Office. 3436 A

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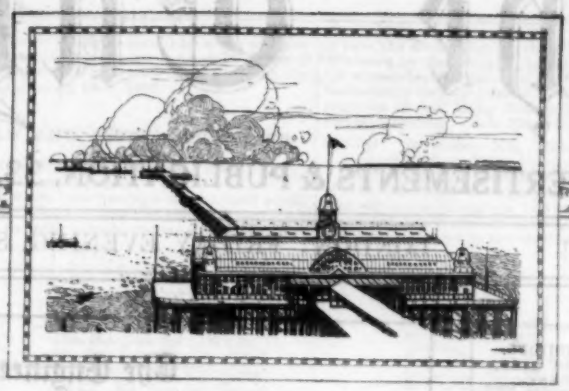

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TELEGRAMS: BATTERY, SELLY OAK
TELEPHONE 151 (3 LINES) SELLY OAK

A Seven-Day Journal

A German Shipyard Loss.

THE recently published balance sheet of the Deutsche Werft A.G. shipbuilding yard at Hamburg indicates that the firm is about to undergo drastic financial reorganisation, largely on account of the unprofitable nature of its transactions during the past two years. The news will not be without interest to British shipbuilders, for it was the Deutsche Werft which in 1925 was successful in securing from Furness, Withy and Co., Ltd., the order for five motor vessels at a price per ship of £60,000 less than that of the lowest British tender. Probably no shipbuilding order has been more fully debated than this one. At the time the reasons assigned for the advantageous price quoted by the German firm included the up-to-date equipment of its shipyard, greater standardisation and less demarcation of labour, as well as lower prices for steel and lower wages. From the balance sheet referred to it would seem to be apparent that both wages and the prices for semi-manufactured steel have since risen high above the prices upon which the tender was based. The net result is that a loss of over 2,500,000 marks has been incurred over a period of two years' working. Losses were sustained not alone on the British ships, but upon two motor ore-carrying vessels constructed by the firm. New shares to the value of 2,500,000 marks are to be issued to the principal shareholders—the Gutehoffnungshütte, the A.E.G. Company and the Hamburg-America Line—and the capital of the company will be reduced by one-half. Furness, Withy and Co., Ltd., may be congratulated on having secured for the Prince Line five motor ships at an exceptionally good price, but the shipbuilder has had to pay the penalty of price cutting. It is probable that the prices quoted by the British firms were those dictated by true economic considerations, but the loss of that order marked the setting up of a Joint Committee of shipbuilders and shipyard employees to examine the conditions under which the industry is carried on in this country. If the findings of the Joint Committee are endorsed by the men's unions then British shipbuilding firms should be in a position to meet continental competition on more than equal terms.

The French Arsenals.

IN the programme of economies to be carried out by the French Government it is proposed to make a cut of 500 million francs in the naval services. This reduction will decide the fate of some of the arsenals, which has been in the balance for years, and if certain of them have not been closed down it is due solely to the efforts of Socialist Governments to keep the arsenals going ostensibly as a means of regulating prices and more particularly of paying wages to the men whether there is sufficient work for them or not. In 1921 a Bill was introduced for maintaining Brest and Toulon as arsenals, while Cherbourg and Bizerta were to become mere bases and Lorient would still be employed for shipbuilding, although it would cease to be a State establishment. Rochefort and Guérigny were to be suppressed, Indret would build engines and boilers, and Ruil would continue to manufacture artillery. As a heavy expenditure would be necessary to give an industrial value to Rochefort, and as Guérigny manufactures armour plates which are no longer needed, their suppression appeared to be justified, but last year the Socialists succeeded in getting a new Bill passed to maintain them. In any case the object of the Government is to effect changes with the idea of cutting expenses and of relying more in the future than in the past upon private shipbuilding enterprise.

The Coal Dispute.

VERY little has been done during the past seven days to advance the cause of peace in the coal industry. At a meeting on Thursday of last week, August 26th, between the miners' representatives and the Chancellor of the Exchequer and other members of the Government the miners' representatives, although the meeting had been arranged at their request, failed to advance a single proposal that would even faintly encourage the return of peace. On Monday, August 30th, the miners' leaders met the members of the Parliamentary Labour Party, but again there was a complete failure to advance any way towards a scheme for the resumption of negotiations with the owners. It would in fact seem certain that among the members of the miners' executive there is now such a division of opinion that any united expression or action to end the dispute is impossible. Instead of the leaders leading, it seems that they have resolved to take guidance from their delegate conference, which was held in London yesterday (Thursday). Meanwhile the tendency of the miners to return to work on local agreements continues to grow in spite of a considerable amount of intimidation. Over fifty thousand miners are now at work in the mines, principally in the Midland area, and their output, together with the supplies received from abroad and from the working of outcrop seams, is in one or two districts rapidly restoring industrial activity to its normal level. Indeed, after four months of idleness at the pits it is surprising and gratifying to observe how magnificently the country's industries are managing to survive the trial. Taking the unemployment figures as our gauge, we find that, excluding those who have ceased work in the coal mining industry, the total number of unemployed on August 23rd was some 215,000 more than on the same date in 1925. That number in ordinary times would be regarded as deplorable, but to-day we have cause for congratulating ourselves that it is not very much greater.

Italian Naval Construction.

STEADY progress is being made with the Italian programme of naval construction. The two cruisers, Trento and Trieste, being built respectively at Leghorn and Trieste, are approaching the launching stage. Each ship displaces 10,000 tons, and will have engines of 150,000 shaft horse-power for a designed speed of 34 knots. Of the twelve new destroyers many have been launched, and the first boat, Quintino Sella, has already run her trials with most successful results. The contract called for 28,000 shaft horse-power and 35 knots, but the actual performance was 35,000 shaft horse-power and 38·2 knots. The Sella is a boat of 1150 tons and is armed with three 4·7in. guns and four 21in. torpedo tubes. She was built at the Pattison Yard, Naples, where three sister vessels are being fitted out for sea. Four small minelayers, each with a capacity of 200 naval mines, are completing at Castellamare. They have low-power Diesel engines and are apparently intended for coastal operations. Four large and eight medium submarines are now on the stocks, the former at Spezia and the latter at Monfalcone. The large boats have a surface displacement of 1360 tons and a surface speed of 18·5 knots. They are understood to be designed for cruising at depths considerably greater than the average diving limit, and are therefore of exceptionally robust construction. Besides carrying a 4·7in. gun and six torpedo tubes, each boat is fitted with a stern tube for discharging mines, sixteen of which are provided. A supplementary programme of construction has been drawn up by the Italian Ministry of Marine, and will probably be put in hand as soon as the necessary credits are opened. It is believed to comprise a number of destroyers and submarines.

Level Crossing Disaster.

THE worst level crossing disaster that has ever occurred in this country happened on Monday afternoon, August 27th, at Naworth, on the Newcastle and Carlisle branch of the London and North-Eastern Railway. At the place in question the line is crossed by a lane, the gates of which are operated by hand and evidently are not interlocked with the signals. About 2.30 p.m. a motor coach arrived at the crossing and a porter opened the gates for it to cross. Just as the vehicle was on the crossing it was run into by an express train, for which, it is said, the signals were at "clear." Eight of the occupants of the motor were killed, as well as the porter. A Ministry of Transport inquiry is to be held and it will, no doubt, be then made clear whether the crossing was that of a public road or was an occupation crossing. If it were the latter its use is without any responsibility to the railway company, but then it becomes a question as to why a porter was employed. His invitation to cross would appear to put the responsibility on the company, but we observe that the company has disclaimed all liability. If the crossing be that of a public road the point to be answered is why the gates were not interlocked with the signals. In that relation it may be asked whether the Act of 1889, which orders the concentration and interlocking of points and signals on passenger lines, includes the interlocking of the gates of public road level crossings?

New British-built Motor Liners.

ON Saturday last, the 28th ult., the new motor liner Accra, built and engined by Harland and Wolff, Ltd., at Belfast, for the West African express service of Elder, Dempster and Co., Ltd.—the British and African Steam Navigation Company, Ltd.—made a preliminary cruise to the Firth of Clyde before taking up her regular service on the 15th inst. The Accra is the third motor liner to be put on the company's West African run, the first motor liner being the Aba, of 1921, and the second the Adda, which joined the fleet the following year. In a few months' time the Apapa, a fourth and a sister ship to the Accra, which vessel was launched last week at Belfast, should be completed. The third and fourth liners are vessels of about 9300 gross tons. They have an overall length of 468ft. 9in., a breadth moulded of 62ft., and a depth moulded of 35ft. Accommodation is provided for a total of nearly 500 passengers and crew. The propelling machinery is designed for a service speed of about 16½ knots. It comprises two sets of Harland-B. and W. six-cylinder, four-stroke, double-acting marine oil engines, each designed for an output of 3750 indicated horse-power. The cylinders have a bore of 840 mm. and the piston stroke is 1500 mm. Three auxiliary oil engine-driven generator sets are fitted, as well as an emergency lighting set. Another motor passenger carrying vessel launched from Harland and Wolff's Govan shipyard at the end of last week is the Koolinda. She is a ship of about 4100 gross tons and has a length of 344ft. and will be propelled by two Harland-B. and W. single-acting, four stroke cycle engines, each rated at 2550 indicated horse-power. The auxiliary machinery will be electrically operated, and an unusual feature is the provision of a 45-kilowatt rotary converter, which will allow the ship to take current from land stations when in port. The Koolinda was built for the Government of Western Australia and will be employed on coasting services.

The Scapa Flow Salvage Operations.

THE operations connected with the refloating of the ex-German battle-cruiser Hindenburg, which are being carried on by Cox and Danks, Ltd., at Scapa Flow, received an unexpected check within the past week or so as a result of a strong gale which swept over the Orkney Islands. One of the already salved German destroyers, which was being used as a breakwater in order to protect the firm's lifting docks and the wreck from northerly winds and tides, was driven against one of the lifting docks, which sustained considerable damage. The necessary repairs were made, but it was found that the storm had caused one of the larger patches on the Hindenburg to give way. It was deemed advisable to sink the ship on an even keel and to overhaul the deck and side patches before attempting the final pumping out operations. With the finer weather pumping was again started on Tuesday morning, and it is hoped that on this occasion no hindrances to the final raising of the ship will be encountered.

The Dutch Motor Liner P. C. Hooft.

THE new Dutch motor liner, Pieter Corneliszoon Hooft, which was recently completed by the Ateliers et Chantiers de la Loire at St. Nazaire and delivered to her owners, the Nederland Steamship Company at Amsterdam, called at Southampton and sailed again yesterday on her maiden voyage to Java. She is the largest motor vessel on the Dutch East Indies route. The new liner has an overall length of about 540ft. and a measurement of about 14,642 tons gross. Her tonnage is greater than any other Dutch motor liner, and she is also the largest motor ship which has yet been constructed in France. Her propelling machinery is also noteworthy, as her two Sulzer eight-cylinder, two-stroke, single-acting engines are the most powerful Sulzer engines of their type. The cylinders have a bore of 680 mm., with a piston stroke of 1200 mm., and each of the two units is designed to give a normal output of 4000 shaft horse-power when running at a speed of 95 revolutions per minute. As usual with this type of machinery the engine controls are arranged on the top platform, but in the P. C. Hooft they are placed at the centre of the engine and not at the forward end. The auxiliary machinery is arranged in the two wings of the main engine-room, and comprises three 325-kilowatt Sulzer Diesel-electric generating sets and a 75-kilowatt generator driven by an airless injection oil engine. Scavenging air is supplied by electrically driven turbo-blowers. The new liner has accommodation for about 625 passengers and her cabin accommodation and public rooms are roomy and are decorated in a pleasing manner, befitting the service in which the vessel is engaged. The new motor liner will shortly be followed by a sister ship, the Christian Huygens, which was recently laid down at the yard of the Nederland Shipbuilding Company at Amsterdam.

Failures at Institution Examinations.

WHAT, we wonder, is the explanation of the poor showing made by many of the candidates presenting themselves for the associate membership and studentship examinations of the Institution of Mechanical Engineers? Are the examination papers set on an excessively high standard or are the candidates who give unsatisfactory accounts of themselves insufficiently prepared for the test? The second explanation appears the more probable. The Council, for the second time, calls attention to the matter in the recently issued August number of the Institution's *Journal*. It states that many of the candidates showed ignorance of the fundamentals of thermodynamics as applied to steam engines and of the use of the steam tables provided at the associate membership examinations held last April. In the studentship examinations, it is stated, there was a large number of failures in "Elementary Mathematics" and "Elementary Mechanics," and many candidates in these subjects failed to realise the meaning of their work and answers. The Council's annual reports do not permit us to form any estimate as to the percentage of the candidates who fail to pass, the number of successful candidates alone being stated. Looking back over the figures for the past five years, we find that the number of candidates passing the associate membership examination or sections thereof showed a steady increase up to 1924, but in 1925 fell off badly. The number passing the studentship examination has been steadily decreasing since 1922.

SOUTHAMPTON DOCKS—INTERIOR OF HYDRAULIC PUMPING STATION

MATHER AND PLATT, LTD., MANCHESTER, ENGINEERS

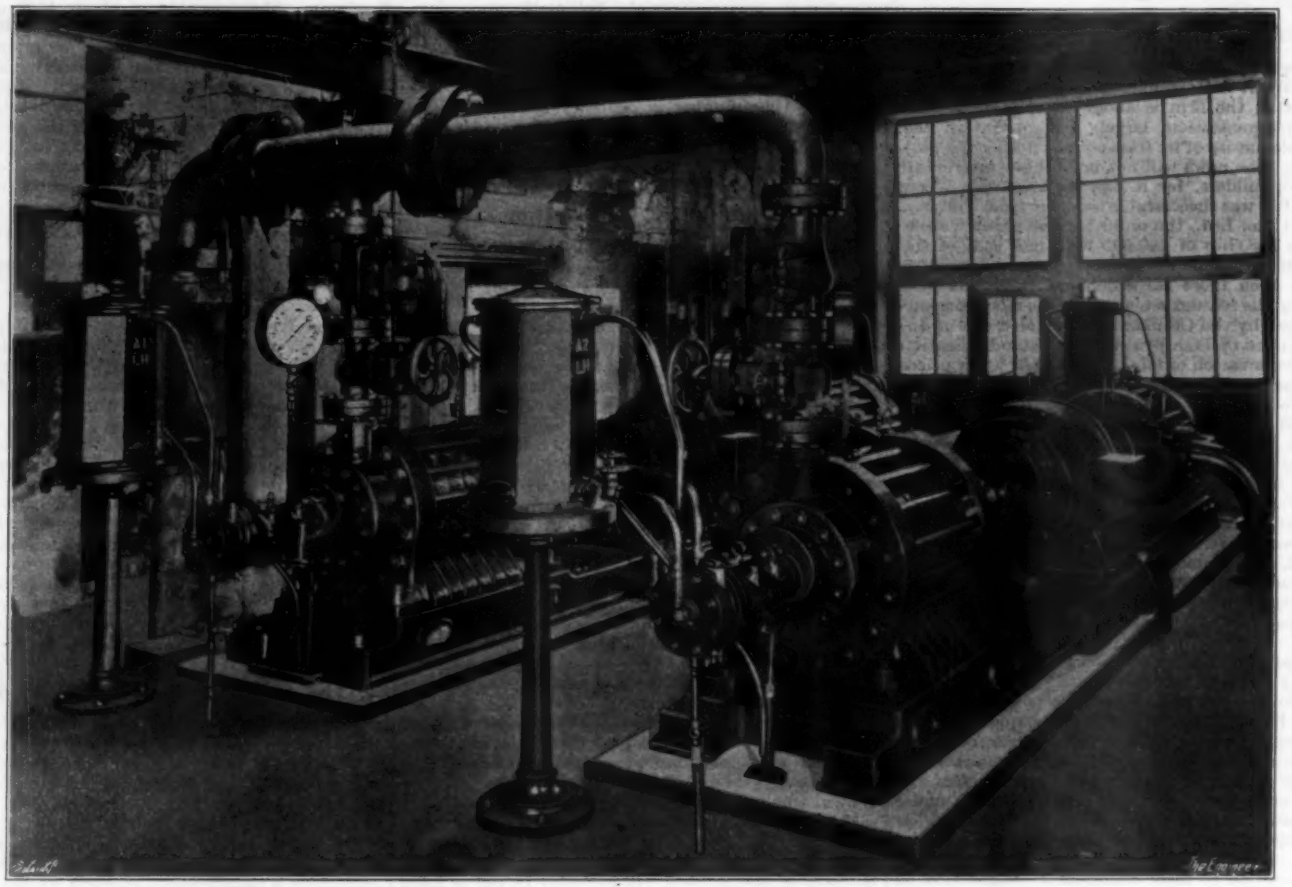


FIG. 21

New Electrical Equipment at Southampton Docks.

NO. III.*

HYDRAULIC INSTALLATION.

As previously mentioned, in addition to the cranes which are operated electrically, many of the cranes are hydraulically worked, the pressure water being provided by three sets of electrically driven multi-stage centrifugal pumps. The main hydraulic supply centre is in No. 3 Pumping Station. There, there are two sets of seventeen-stage electrically driven pumps, which were made by Mather and Platt, Ltd., of Manchester. Each set is designed to deliver 200 gallons of sea water per minute against a pressure of 750 lb. per square inch, and each is coupled directly to a 165 brake horse-power slip-ring induction motor running at 1470 revolutions per minute on a 415-volt, 50-cycle, three-phase circuit. The starting and stopping of these motors which, we many explain, are arranged on a floor approximately at ground level and about 26ft. above the de-watering pump floor, is automatically controlled by tappets on a hydraulic accumulator, the rise and fall of which cuts out or cuts in the motors as the demands made by the cranes, &c., and hence the pressure, varies. Sea water is used for the pressure mains, and a supply of water for that purpose is fed into an overhead tank by two electrically worked three-throw ram pumps supplied by A. G. Mumford, Ltd., of Colchester, their working being automatically controlled by a float in the supply tank. By this means there is always a positive head of 8ft. on the suctions of the pressure pumps. It may be explained that no attempt is made to circulate the pressure water, the discharges from the cranes being always to the sea, and new water continuously supplied to the pressure pumps.

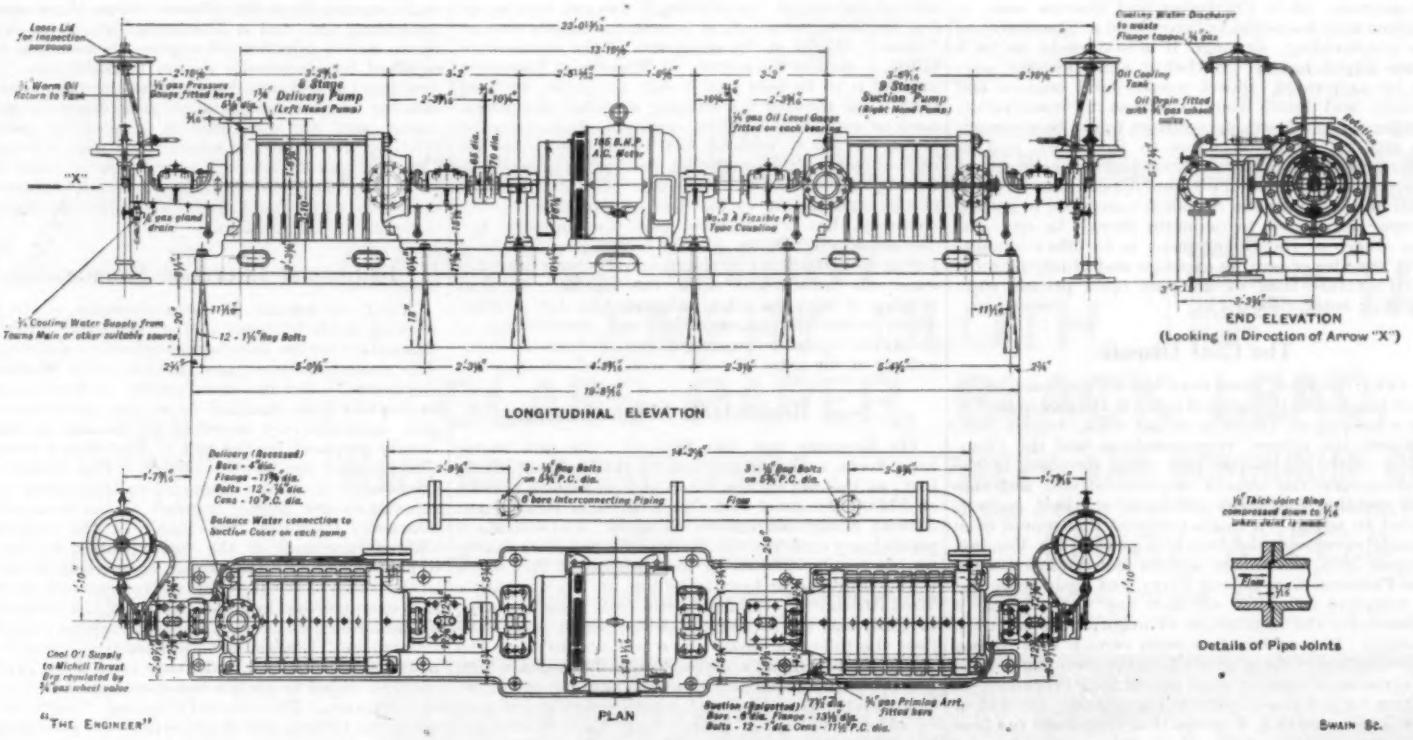


FIG. 22—ELEVATIONS AND PLAN OF HYDRAULIC PUMPING PLANT

As a supplement to the two pressure pumps in Station No. 3 there is also a further seventeen-stage pump in a gallery above the pump floor of Pumping Station No. 5. It, however, is not driven by a three-phase motor, but by a direct-current variable-speed

* No. II. appeared August 27th.

motor. The use of direct current in this instance allows of a ready adjustment of load between the pumps at Stations Nos. 3 and 5, when they are running together. Any two of the three pumping sets are capable of supplying all the hydraulic needs of the docks, which, we understand, does not exceed 400 gallons of pressure water per minute even at peak loads.

The water used for hydraulic power is continuously measured by integrating and recording Venturi meters manufactured by George Kent and Co., Ltd.

The arrangement of the two pumping sets in No. 3 Station is shown in Fig. 23, while a view of the two sets *in situ* is given in Fig. 21, and an elevation and plan drawing in Fig. 22. Each pumping set consists of two "Plurovane" high-lift turbine pumps acting in series, the motor being placed between the pumps and coupled direct to them through pin type flexible couplings, the complete unit being on a single bedplate. A longitudinal section through one of the pumps is given in Fig. 24. The low-pressure part of the pump has nine chambers and the high-pressure part eight chambers, thus making up the seventeen chambers. One of the chambers is, however, a dummy, so that, correctly speaking, there are actually only sixteen pressure steps in each set. We are informed that each set gives a duty of 200 gallons of sea water per minute against 1680ft. head—728 lb. pressure—with an efficiency of 70 per cent. at a speed of 1470 revolutions per minute.

The pumps are fitted with automatic disc-balancing devices to eliminate hydraulic thrust, while to take care of the thrust when the machines are just commencing to run, and as a safeguard against the effects of heavy load fluctuations in service, Michell thrust bearings, with oil circulation and oil cooling tanks, are fitted to each pump.

The 165 brake horse-power alternating-current motors are of the firm's standard induction type, with pedestal ring oiled bearings. The makers inform us that, in view of the somewhat exacting conditions in which the motors have to operate, special attention was given to their windings and insulation. The stator windings are insulated with mica sheet mechanically protected by leatheroid, the whole forming a complete sealed insulating tube enclosing the straight part of each half coil and extending for some distance beyond the core. For the rotor windings solid copper strip, insulated and treated in a manner similar to that employed for the stator windings, is used. The slip rings are of bronze shrunk over mica insulation on to a metal sleeve keyed to the shaft, and were specially designed for continuous operation in connection with the automatic control gear. The latter, which, as explained above, is actuated from the accumulator by tappet switches, is totally enclosed. Magnetically operated contactors for the stator and rotor circuits start and accelerate the motors up to full speed, the time of closing the contactors being governed by a mechanically operated master controller with an adjustable time element. It is a matter of only a few seconds between the time of the closing of the first contactor and when the motors have run up to full speed and the pumps are fully at work. A triple-pole isolating switch is provided, while no-volt protection is embodied in the design of the contactor coils. We may add that the control gear was designed for starting forty times per hour against load.

The pumping set in No. 5 Station is identical with those in No. 3 Station, saving that the 165 brake horse-power motor is a direct-current machine wound for 480 volts. The automatic control gear follows the same general lines as does that for the alternating-current motors.

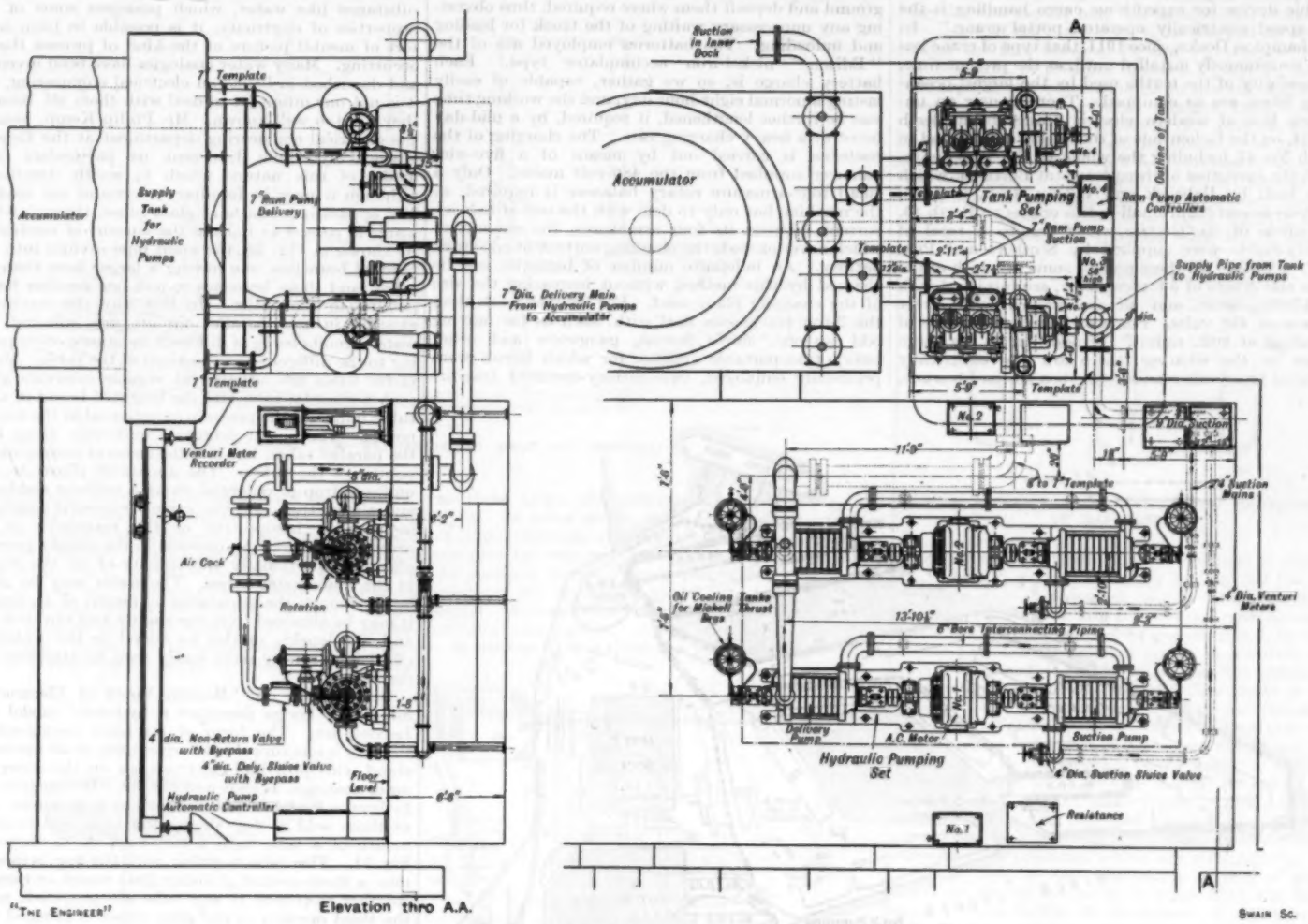


FIG. 23—ARRANGEMENT OF HYDRAULIC PUMPS IN NO. 3 PUMPING STATION

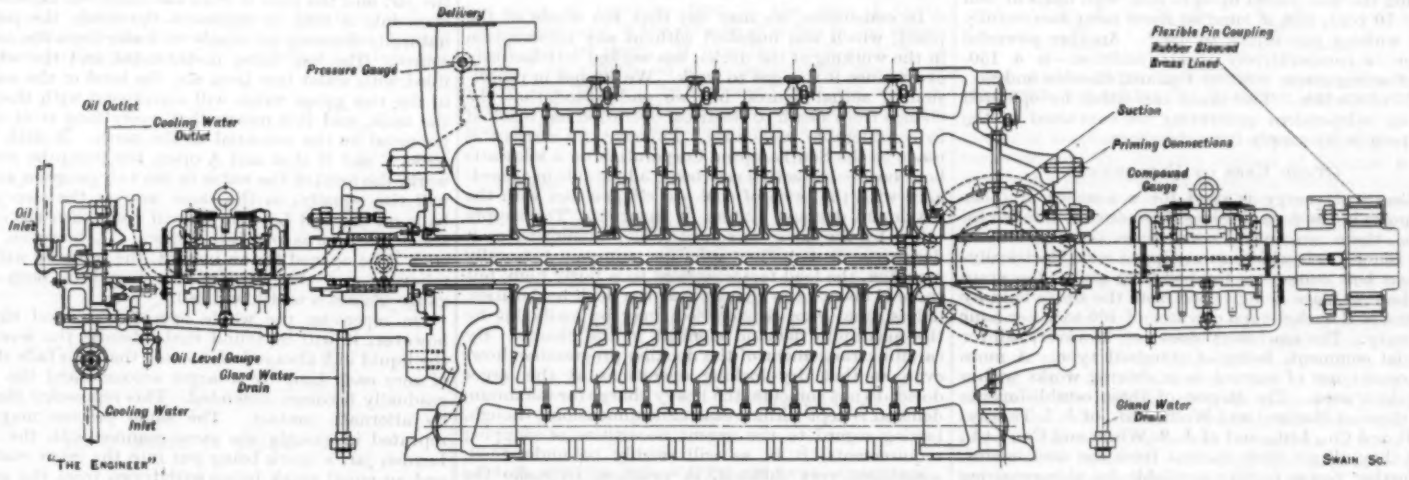


FIG. 24—SECTION THROUGH "PLUROVANE" HYDRAULIC PUMP

Electric Crane Equipment.

The electric crane equipment, as will have been gathered from the plan which was given on page 189 *ante*, is very extensive. In referring to it we cannot, we think, do better than quote from a paper entitled

"Southampton Docks Electric Supply and Plant," which was read by Mr. Wauchope before the British Association when it met at Southampton in August, 1925, and to which we are already indebted for some of the particulars given in the foregoing.

"Undoubtedly," says Mr. Wauchope, "one of the most important factors influencing the success or otherwise of a modern docks is its equipment of wharf appliances for the handling of cargo. The general concensus of opinion nowadays is that the most flexible device for expeditious cargo handling is the high-speed electrically operated portal crane." In Southampton Docks, since 1911, that type of crane has been continuously installed until, at the present time, the majority of the berths used by the largest ocean-going liners are so equipped. There is now an unbroken line of modern electric cranes from Berth No. 34, on the Itchen side of the docks, right round to Berth No. 47, including the whole of the Test quays. With the exception of three cranes at Berth 41, which were built by Babcock and Wilcox, Ltd., in 1915, and two second-hand small-radius cranes on Berth 45, the whole of the electric wharf cranes—a total of twenty-eight—were supplied by Stothert and Pitt, Ltd., of Bath. All these cranes, some of which are of 2-ton and others of 5-ton capacity, are furnished with level-luffing gear, and all are worked with direct current at 480 volts. Some of them are capable of operating at 90ft. radius. In addition to the cargo cranes on the wharves, there are two electrically operated heavy-lift cranes. One is a 50-ton jib crane, which works alongside No. 6 Dry Dock and which has a radius of 87ft. This crane, another Stothert and Pitt production, which has been in service since 1904, was, during the war, called upon to deal with loads of well over 70 tons, and it handled them most successfully and without any injury to itself. Another powerful crane—a comparatively recent addition—is a 150-ton floating crane, built by Cowans, Sheldon and Co., Ltd., of Carlisle. This crane can either be operated by an independent generating set contained in the pontoon or by supply from the shore.

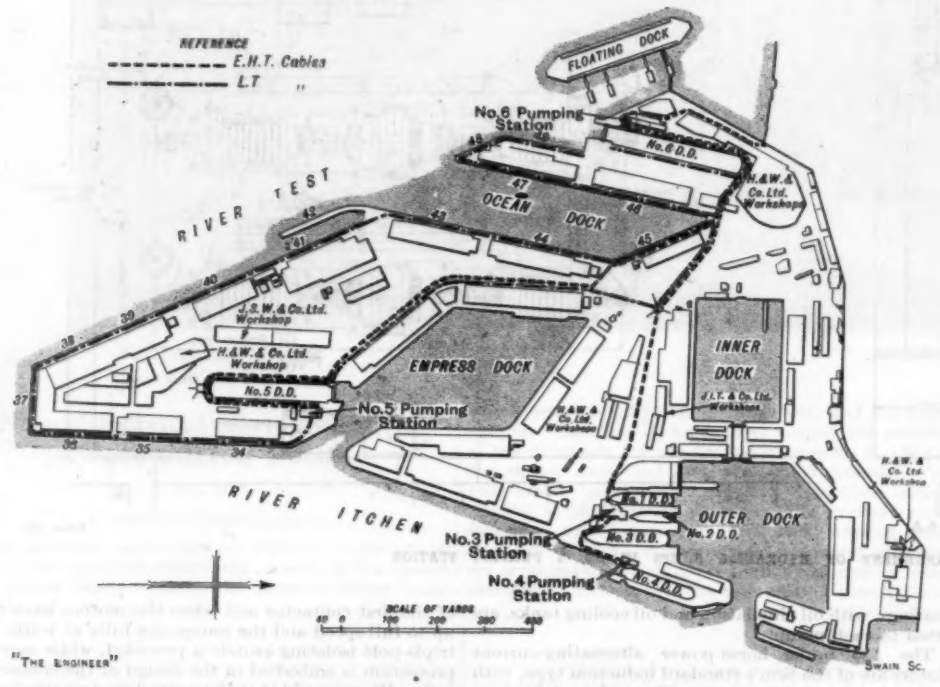


FIG. 25—PLAN OF SOUTHAMPTON DOCKS SHOWING ELECTRIC POWER MAINS

Other Uses of Electricity.

Electrical energy is used for a number of other purposes in the docks besides those already alluded to. Thus, there are several warehouses situated around the Inner Dock which are equipped with electrically-driven belt conveyors for handling grain, the grain in the first place being raised from the ship's hold by means of a bucket-type elevator of 100 tons per hour capacity. The machinery does not, however, call for special comment, being of standard type. A more important use of current is in driving works within the dock area. The largest of these establishments are those of Harland and Wolff, Ltd., of J. I. Thornycroft and Co., Ltd., and of J. S. White and Co., Ltd., and they all get their current from the dock mains. A further power facility available for ship-repairing work, and also for ship-coaling operations, is provided by an extensive system of mains laid throughout the docks. We understand that power up to at least 50 kilowatts is obtainable at any berth in the docks for driving air compressors or coaling machines, electric welding and other purposes. At the newer berths, power up to as much as 100 kilowatts is available. A plan showing the lay-out of the cables is given in Fig. 25.

Another direction in which electrical energy is most successfully employed is the operation of electrically-propelled battery trucks. After exhaustive tests of many types of such vehicles, it was decided to standardise for dock use the electric elevating platform truck made by the Elwell Parker Electrical Company, Ltd., and there are now some twenty-eight of these useful little vehicles in service. The truck is of a particularly robust construction and has a load capacity of 2 tons. The load to be carried is loaded on wooden trays or tables, and the truck platforms are arranged to slide under these trays, and by an elevating device to lift them from the ground and deposit them where required, thus obviating any unnecessary waiting of the truck for loading and unloading. The batteries employed are of the "Edison" nickel-iron accumulator type. Each battery charge is, so we gather, capable of easily lasting a normal eight-hour day, and the working time can be further lengthened, if required, by a mid-day boost at a heavy charging rate. The charging of the batteries is carried out by means of a five-wire balancer supplied from the 480-volt mains. Only a small four-armature rotary balancer is required, as the machine has only to deal with the out-of-balance current between its four armatures, the amount of which never exceeds the charging current of one truck battery. An indefinite number of batteries can be charged by this method without increasing the size of the charging plant used. For heavier work than the 2-ton trucks can deal with, such as for moving odd wagons, ship's booms, gangways and other heavy transportable articles, for which horses were previously employed, two battery-operated tractors are used. They also were supplied by the Elwell Parker Electrical Company, Ltd.

Conclusion.

In conclusion, we may say that the whole of the plant, which was installed without any interruption in the working of the docks, has worked satisfactorily every since it was got to work. We are not in possession of actual figures, but we understand that the change from steam to electrical operation has resulted in considerable economies. Payment for current is made to the Southampton Corporation on a kilowatt-hour basis—the actual rate being adjustable in accordance with the price of coal—in conjunction with the maximum demand system of charging. The supply taken by the docks is considerable, amounting as it does to over 4 million units per annum. Generally speaking, the load factor worked to is fairly high, but there is always the chance that the dock authorities, unless great care is exercised, may be badly hit by the maximum demand element in the charge. By careful arrangement of the docking programme, however, so that dry-docking operations at the larger docks do not coincide, the heavy charge for maximum demand is kept within reasonable dimensions, though, having regard to the urgent necessities of shipping requirements, it is, as will readily be understood, sometimes very difficult, in practice, to make the necessary arrangements. However, taking all circumstances into consideration, the dock management has every reason to be satisfied that, in embarking on the large electrical scheme which is described in the foregoing, a step in the right direction was taken, and that its action in embarking on the change of motive power will be amply justified by greatly increased economy and flexibility of the power services in the docks.

Finally, we would express our thanks to Mr. Wauchope for the very considerable assistance he has been to us during the preparation of these articles.

Models and Analogies for Demonstrating Electrical Principles.

NO. IV.*

Water analogies are, of course, frequently employed to explain electrical principles. As electricity is not a concrete substance that can be seen, it is rather difficult to think about it; but by choosing a tangible substance like water, which possesses some of the properties of electricity, it is possible to form some sort of mental picture of the kind of process that is occurring. Many water analogies have been invented and described in books on electrical engineering, but it is not our intention to deal with them all, because they are too well known. Mr. Philip Kemp, head of the electrical engineering department at the Regent-street Polytechnic, has sent us particulars of a model of this nature which is worth describing, although it may be familiar to some of our readers. The apparatus consists of glass tubes, through which water is passed to imitate the current of electricity. As shown in Fig. 29, the main pipe divides into two parallel branches, one having a larger bore than the other, and these branches re-join one another before passing to the outlet. In this way the conditions existing in two parallel circuits are imitated, the water circuits being of different resistance corresponding to the different cross sections of the tubes. Manometer tubes are situated at regular intervals along each horizontal tube, and the height of liquid in these tubes indicates the pressure or potential at the various points. The height decreases uniformly along both the parallel tubes, but it is the same at corresponding points on the tubes. The apparatus illustrates the uniform drop of potential along a uniform conductor and shows that it is the same for circuits connected in parallel, irrespective of the resistance of the several branches. An increase in the supply pressure affects proportionally the heights of all the liquids in the manometer tubes. The water may be circulated through the apparatus by means of a pump or it may be obtained from the supply and run to waste, and if colouring matter be added to the water the effect is naturally more easily seen by students at a distance.

In his book on "Modern Views of Electricity," Sir Oliver Lodge describes a hydraulic model of a Leyden jar. The form of jar most convenient to think of is one supported horizontally on an insulating stand with pith ball electroscopes on the inner and outer coatings, as shown in Fig. 30. To construct the hydraulic model, a thin rubber bag is procured, such as those sold at toy shops, and it is tied over the mouth of a tube with a stop-cock A, as shown in Fig. 31. This tube, together with the bag, is inserted into a three-necked globular glass vessel or receiver. Another stop-cock B and tube are provided, whilst the third opening in the glass vessel is plugged by a cork, after the whole vessel, both inside and outside the bag, has been completely filled with water without air bubbles. This arrangement then represents the insulated Leyden jar. The bag represents the dielectric, and its inner and outer coatings are the spaces filled with water.

Open gauge tubes *a* and *b* are provided to correspond to the electroscopes on the actual jar, whilst a third vent tube C, connecting the inner and outer coatings, corresponds to a discharger. Under ordinary conditions, however, the cock C will, of course, be shut. A water pump applied to the tube A will represent an electrical machine connected to the inner coating of the jar, and the pipe B from the outer coating should open into a tank to represent the earth, the pump naturally drawing its supply of water from the same source. The bag being undistended and the whole filled with water free from air, the level of the water in the two gauge tubes will correspond with that in the tank, and that means that everything is at zero potential or the potential of the earth. If with the cocks C and B shut and A open, the pump be set to work, the level of the water in the two gauges *a* and *b* will rise equally, in the same way as the two pith balls on the real Leyden jar will rise, when the electrical machine is put into action. If, however, the cock B be opened for an instant, the pressure will be relieved, and the level of the liquid in both the gauge glasses *a* and *b* will fall.

On repeating the whole operation several times, however, it will be found that whereas the level of the liquid in *b* always falls to zero that in *a* falls short of zero each time by a larger amount, and the bag gradually becomes distended. This represents charge by alternate contact. The same process may be repeated in exactly the same manner with the real Leyden jar, a spark being put into the inner coating and an equal spark being withdrawn from the outer coating each time, and unless this outer spark is withdrawn the jar declines to charge, water (and electricity) being incompressible.

If the cock B be left permanently open, the pump can be steadily worked, so as to distend the bag and raise the gauge *a* to its full height, the liquid in *b* remaining at zero all the time, save for oscillatory disturbances. When the "jar" has been charged, the cock A may be shut, and the pump removed, and the end A may be connected with the tank directly. By

* No. III. appeared August 27th.

means of the discharger C the fluid can be transferred from the inner to the outer coating, when the strain will be relieved, and the gauges will be equalised. But if this operation be performed while the jar is "insulated"—that is to say, whilst the cocks A and B are shut—the common level of the gauges after discharge is not zero, but a half-way level, and the effect of this is noticeable if a Leyden jar be charged ordinarily, then be insulated, discharged and touched.

Instead of using the discharger C, however, the operator may proceed to discharge the jar by alternate contact, and the operation is very instructive. A start is made with the gauge *b* at zero, and the gauge *a* at high pressure. On opening the cock A some water is squeezed out of the inner coating, and the gauge *a* falls to zero, but the suck of the contracting bag on the outer coat lowers the level of the liquid in the gauge *b* below zero, the descent of the two gauges being nearly equal. On shutting the cock A and opening B a little water flows in from the tank, thus

FIG. 30—LEYDEN JAR

still further relieving the strain of the bag, and the levels of the gauges both rise, *b* to zero and *a* to something just short of its old position. On shutting the cock B and opening A again, the two gauges again descend, whilst on reversing the operation they both rise again, and so on, until the bag has recovered its normal size.

This is discharge by alternate contact, and it exactly imitates the behaviour of an insulated charged Leyden jar, having its inner and outer coatings put

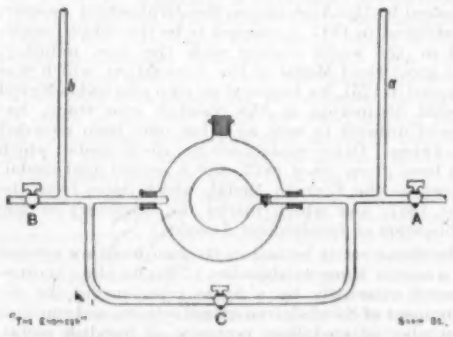


FIG. 31—MODEL OF LEYDEN JAR

to earth. Its pith balls alternately rise with positive and negative electricity respectively, indicating potentials above and below zero. Illustrations of the actual model are to be found in "Modern Views of Electricity."

The analogy between difference of potentials and difference of fluid pressures is so marked that the word "pressure" is often used to stand for the difference of potentials. An apparatus for testing the distribution of water pressure as described in Ayrton and Mather's "Practical Electricity" is shown in Fig. 32. If the bottom tube *t t* be straight and of uniform cross-section, and if the flow of water in the tube be steady, the tops of the water columns in the standpipes S_1–S_6 will all lie in a straight line, as shown at Q_1–Q_6. Thus, if the length $P_1 P_2$ of the uniform tube be equal to the length $P_4 P_5$, the difference between $P_1 Q_1$—the height of the water in the standpipe S_1—and $P_2 Q_2$—the height of the water in the standpipe S_2—is exactly equal to the difference between $P_4 Q_4$ and $P_5 Q_5$. If the length P_1–P_4 be three times the length $P_4 P_5$, the difference between $P_1 Q_1$ and $P_4 Q_4$ is equal

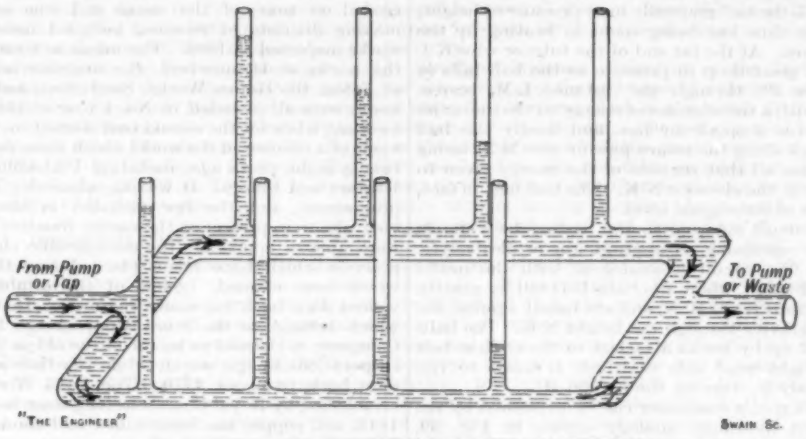


FIG. 29—MODEL FOR DEMONSTRATING DROP OF POTENTIAL

to three times the difference between $P_4 Q_4$ and $P_5 Q_5$. In other words, when there is a steady flow of liquid through a uniform tube, the difference of pressure between any two points is proportional to the distance between those points, and this is true whatever the inclination of the tube *t t* to the horizontal, provided that the tube is straight and of uniform cross section.

If the tap T_1 and the screw pinch cock S_1 be fully

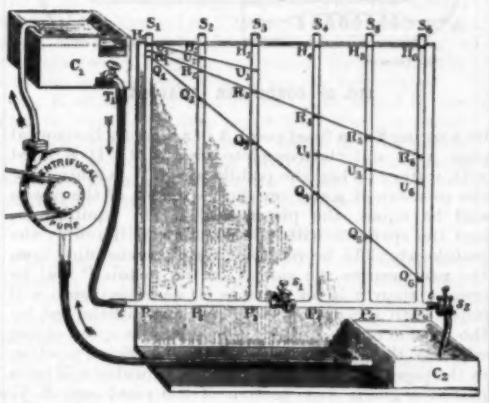


FIG. 32—APPARATUS FOR TESTING THE DISTRIBUTION OF WATER PRESSURE

open, and the screw-pinch cock S_2 be fairly open, the stream of water through the tube *t t* will be rapid, and the slope of pressure—that is, the line Q_1 Q_2–Q_6 joining the tops of the column of water in the standpipes, will be steep. If now the pinch cock S_2 be screwed up a little, so as to impede the passage of water, the flow will be decreased, and the slope of pressure R_1 R_2–R_6 will be less inclined to the horizontal than Q_1 Q_2–Q_6. As the pinch cock S_2 is more and more

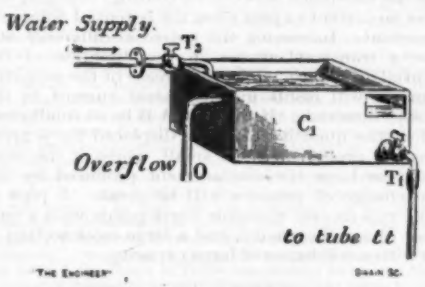


FIG. 33—CISTERN FOR WATER-PRESSURE APPARATUS

screwed up, the pressure line will become more and more horizontal, until when the flow is entirely checked the line H_1 H_2–H_6, joining the tops of the columns of water in the standpipes, becomes quite horizontal, and at the same level as the water in the cistern C_1.

From this it is seen that the pressure is the same at all points along the horizontal pipe P_1 to P_6, through which no flow of water is occurring, so that there is no difference of pressure between any two points along the pipe, and as "difference of potential" is analogous to fluid pressure, it may be concluded that there is no potential difference between points in an electrical conductor through which no current is passing. In other words, all points of an electrical conductor on which electricity is at rest are at the same potential. If there be any flow, the level of the water in the first standpipe S_1 is less than that in the cistern itself, this level being made visible by a little glass window on the right-hand side of the cistern C_1. This is on account of the resistance offered to the flow by the tap T_1 and the india-rubber tube $T_1 t$. Similarly, if the pinch cock S_1 be screwed up so as to check the flow between P_3 and P_4, there will be a sudden drop in pressure between P_3 and P_4, so that the tops of the water columns in the standpipes will then assume two different straight lines U_1 U_2 U_3 and U_4, U_5 and U_6, parallel to one another, but the latter, U_4, U_5 and U_6 will be much lower than the former. As the pinch cock S_1 is screwed up more and more, the lines U_1 U_2 U_3 and U_4 U_5 U_6 will become more and more horizontal, but at a greater distance from one another until when S_1 is entirely closed the former line will coincide with H_1, H_2 and H_3

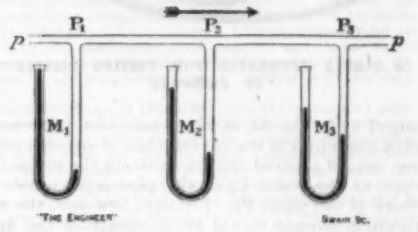


FIG. 34—APPARATUS FOR TESTING THE DISTRIBUTION OF GAS PRESSURE

while the latter will sink down to the level of the tube P_4 P_5 and P_6 itself. In a very similar way the electrical pressure or potential, as it is usually called, at different points of a wire conveying a current can be measured, and if a number of measurements be made of the potential at different points of a circuit conveying a current, it will be found that the results are smaller and smaller as the tests are made in one direction, and if the conductor be of uniform gauge and material and the electric current be a steady one, the potential difference between any two points will be found to be proportional to the length of the conductor between those points. Electricity is put into motion and a current of electricity is produced as a consequence of the potential varying from place to place, just as a current is produced in water when subjected to pressures which are not uniform. In order to produce and maintain a current of either water or electricity, work of some kind has to be done. Thus, in Fig. 32 the current of water in the tube *t t* will gradually diminish as the water passes from the upper to the lower reservoir, and will cease entirely as soon as the reservoir C_1 is empty. In order to maintain the current it is necessary to provide some

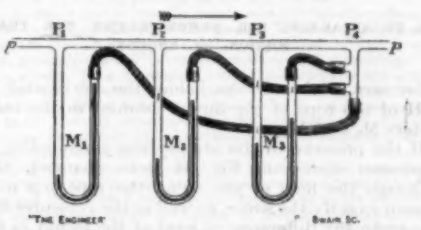


FIG. 35—APPARATUS FOR TESTING DISTRIBUTION OF PRESSURE RELATIVELY TO PRESSURE AT ONE POINT

means of keeping up the level of water in the upper reservoir, and the simplest method of doing so is by means of a pump working at such a rate that water is raised from the lower vessel C_2 to the upper one C_1, just as fast as it flows from C_1 to C_2 through the tube *t t*. The voltaic cell and the dynamo correspond exactly with this pump, for a current generator does not create electricity any more than a fire-engine creates water. It merely sets it in motion, and in either case work has to be done in keeping up the flow.

In the case of the water flow, operations may be commenced by filling the reservoir C_1 and by maintaining the level by allowing water to flow from the cistern of the building into the reservoir C_1 as fast as it flows out, or to save trouble, the water may be run into the reservoir rather faster than it flows out through the tubes *t t*, and allow the surplus to flow out through the overflow pipe O in Fig. 33. With the latter arrangement the level of the water in the reservoir C_1 will remain automatically constant whatever the flow through the tube *t t*, provided, of course, that the tap T_2—Fig. 33—be opened wide enough to cause the flow from the house cistern into the reservoir never to be less than the flow out of the tube *t t*.

If the substance flowing were a gas, the distribution of pressure could not be measured by standpipes, for if the pipes were open the gas would flow out or the outside air would flow in, and if the pipes were closed they would all be filled with the gas itself or with a mixture of gas and air. The distribu-

tion of pressure along a pipe *p p*—Fig 34—conveying a stream of gas might be measured relatively to the outside atmospheric pressure by means of manometers M_1, M_2 and M_3 attached to the points P_1, P_2, P_3 of the pipe, the difference of level of the liquid on the two parts of the tube of each manometer measuring the excess of the pressure of the gas at that part of the pipe over the atmospheric pressure, or if it be desired that the measurements should be independent of the atmospheric pressure and merely to show the pressures at the various points of the pipe, relatively to the pressure at one point P_4, manometers might be

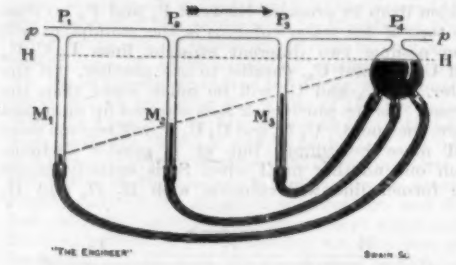


FIG. 36—SIMPLE APPARATUS FOR TESTING DISTRIBUTION OF PRESSURE

arranged as in Fig. 35, in which case the difference of level of the liquid in the curved tube of any one manometer, say, M_2, would show how much the pressure of the gas at the point P_2 of the pipe *p p* exceeds the pressure at the point P_4. Perhaps, however, the most convenient scheme would be to construct the apparatus as shown in Fig. 36, since the pressure of the gas at any point P_2 relative to the pressure P_4 would be at once seen from the distance the top of the column of liquid in tube M_2 was below the horizontal line H H, and the difference of pressure of the gas at any two points P_2 and P_3 would therefore be measured by the

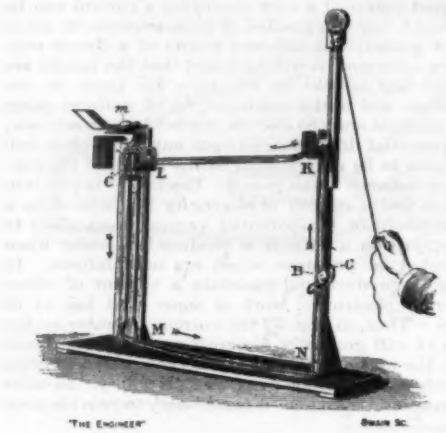


FIG. 37—APPARATUS FOR DEMONSTRATING THE TRANSMISSION OF ENERGY

difference in the depths below the horizontal line H H of the tops of the liquid columns in the manometers M_2 and M_3.

If the pressure of the atmosphere surrounding the apparatus shown in Fig. 34 were changed, then, although the flow of gas along the pipe *p p* might remain exactly the same, as well as the pressures at its two ends, the difference of level of the liquid in each of the manometers shown in this illustration would change, but the level of the liquid in the manometer shown in Fig. 36 is wholly independent of the outside atmospheric pressure, and depends solely on the

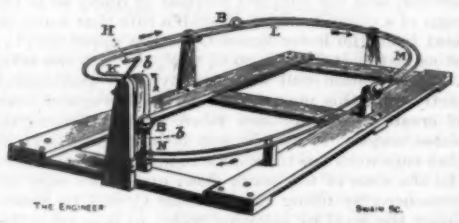


FIG. 38—MODEL OF A SIMPLE ELECTRICAL CIRCUIT

length, cross section, shape and internal character of the pipe *p p*, on the rate of flow, and on the nature of the fluid flowing through the pipe. These manometers give no information concerning the absolute pressure of the gas at the different points of the pipe, through which it is flowing, but only the pressures relative to the pressure at the point P_4.

In the same way the electric potential of a point in a wire through which a current is flowing is usually measured relatively to that of some other point of the wire, and even when one point of the wire is connected with the earth and the potentials at different points of the wire are measured above and below the potential of the earth, which is arbitrarily called "naught," it is still but a relative measurement, for in thus taking the potential of the earth as the potential level to measure flow, no assumption is made as to the earth having no electricity on it.

Another model described in Ayrton and Mather's "Practical Electricity" is shown in Fig. 37, and it has been designed to demonstrate in a rough symbolical way what takes place in the transmission of energy. The working medium, water, air or electricity, is first raised in pressure, and has energy given to it. In the model it is symbolised by a ball B, which is raised in a carrier C, through a height N K, against the action of gravity. As it proceeds along the tube or wire K L the ball gradually loses pressure or height, the energy thus lost being spent in heating up the tube or wire. At the far end of the tube or wire K L there is a great drop in pressure as the ball falls in the carrier C^1, through the distance L M, corresponding with a transference of energy to the motor *m*, which drives a small air fan, and finally the ball comes back along the return pipe or wire M N, losing as it returns all that remains of the energy given to it initially in the elevator N K. The ball has, in fact, come back to its original level.

If the circuit external to the battery be a simple resistance containing no electromotor or electrolytic cell, then the circuit is analogous with the model shown in Fig. 38, where the balls B B fall by gravity along the rails K, L, M, N, and are raised against the action of gravity through the height N K. The balls are picked up by hooks attached to the endless belt *b b*, the right-hand side of which is made to rise continuously by turning the handle H.

The action of a condenser can be explained by the well-known hydraulic analogy shown in Fig. 39, which is also taken from Ayrton and Mather's "Practical Electricity." A close-fitting piston P is attached

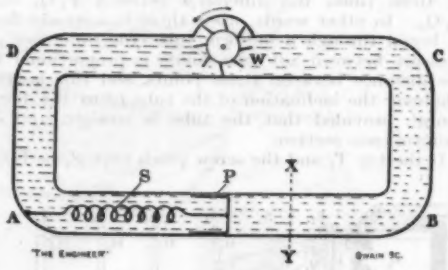


FIG. 39—CONDENSER ANALOGY

by a spring S to a fixed point A in a smooth horizontal pipe A B, and the complete pipe A B C D is filled with water. When the paddle wheel W is stationary the pressure of water on the two sides of the piston will be equal, the piston will be in equilibrium, and the spring S will be unstretched. If, now, the paddle wheel W be rotated in a clockwise direction, the pressure on the side A of the piston P will be greater than it is on the side B, and the piston will move until the difference of pressure is balanced by the tension of the spring. For a definite speed of the wheel W the piston P will take up a definite position in the pipe, and a definite quantity of water will have passed a given cross section of the pipe, say, X Y. An increase in the speed of the wheel W will increase the difference of pressure, increase the displacement of the piston P, and also the water past X Y, whilst a decrease in the speed will result in a diminution of the displacement and cause a quantity of water to move in the direction B A. As long as the speed of the wheel W remains constant and no leakage past the piston occurs, there will be no movement—or current—of water in the pipe A B, but any change of speed will cause a transient current to pass in one direction or the other, according as the speed rises or falls. In the same way an electrical condenser allows transient currents to pass; that is to say, permits quantities of electricity to be displaced when the potential difference between its coatings changes, but allows no current to pass when the potential difference is constant. Increasing the potential difference will cause a transient current in the direction of the potential difference, whilst a decrease of the potential difference will result in a transient current in the opposite direction. If the pipe A B be of small cross section, the quantity of water displaced for a given change of pressure will be small, whilst if the cross section be large the displacement produced by the same change of pressure will be great. A pipe of small cross section therefore corresponds with a condenser of small capacity, and a large cross section of pipe with a condenser of large capacity.

Iron and Steel Institute.

No. I.

STOCKHOLM MEETING.

THE autumn meeting of the Iron and Steel Institute, which opened in Stockholm on August 26th with a reception in the house of the Swedish Ironmasters' Association—Jernkontoret—is the second which has been held in Sweden by the Institute, the previous visit having been in the year 1898, when King Oscar was on the throne of Sweden and the late Mr. E. P. Martin was President of the Institute. There was a representative attendance of members of the British iron and steel industry for that visit to Sweden, those who took part in it including Sir James Kitson, afterwards the first Lord Airedale, Professor Roberts Austen, Mr. Adolph Greiner, who was destined to become President of the Institute, Mr. Windsor Richards, Mr. W. H. Bleckley, and Mr. Snelus.

The programme on that occasion was distinguished by an interesting series of visits to mines and iron and steel works, and the programme, which was carried out last week when two separate parties proceeded on tours of the mines and iron and steel-making districts of Sweden, included most of the works inspected in 1898. The mines at Grangesberg, the works at Domnarfvet, the museum and mines at Falun, the Hofors Works, Sandviken, and Dannemora, were all included in No. 1 tour of the present meeting, while for the second tour a selection had been made of a number of the works which were also visited twenty-eight years ago, including Uddeholm, Laxa, Hagfors and Bofors. It was an admirably arranged programme, and the few included in the present visit who were present at the earlier Swedish meeting were able to appreciate the considerable changes in practice which have taken place during the years which have elapsed. Some of the establishments visited date back for many centuries. Domnarfvet, which belongs to the Stora Kopparbergs Bergslags Company, is claimed to be one of the oldest industrial corporations in the world, while the Gellvare Mines date back to about 1770. The Laxa Works were established by Royal Charter as long since as the year 1643, and copper has been mined at Falum for over 700 years.

The reception on August 26th, at which visiting members of the Institute were received by Mr. Jonas C. Kjellberg, President of Jernkontoret, enabled the famous house of that great corporation to be inspected. The Swedish Ironmasters' Association is an institution which is believed to be without exact parallel in any other country. It has been in existence for 179 years, having been founded, it is believed, by a Swedish merchant, by name Andreas Backmansson, with the primary object of rendering financial assistance to Swedish ironmasters in times of crisis.

There was a natural desire on the part of the native ironmasters to free themselves from financial dependence on foreign customers, to whom many of them were in debt, a condition of affairs which was taken advantage of to depress the price of Swedish iron. On the foundation of Jernkontoret, the membership of which included the principal ironmasters of the time, the Government granted the right to the associated works to open a credit at the State Bank against iron held for export, and the Association also received authority to buy iron when necessary and hold it until market conditions presented a favourable opportunity for sales. The total assets of the Association at the beginning of the present year were approximately £520,000. The rules have been revised from time to time, but the objects of the Association remain substantially the same. They are to support and promote the interests of the iron industry by means of loans to members and by grants in aid of scientific and technical research. Technical and educational functions of the organisation were first undertaken in the year 1751, when the famous metallurgist, Sven Rinman, was appointed chief smelting master, and charged with the work of supervising and improving blast-furnace practice. The fostering of technical knowledge and progress in metallurgy and fuel technology has ever since been one of the chief aims of Jernkontoret, out of the income of which about £10,000 a year are paid in subventions for scientific research and technical education.

When the new post of chief engineer was created in 1903, Mr. J. A. Brinell was appointed to occupy it, and held it until the year 1914. The periodical, which is issued by the Association, the *Jernkontoret Annaler*, established in 1817, is claimed to be the oldest periodical in the world dealing with the iron industry. The great Gold Medal of the Association, which was founded in 1751, for bestowal on men who had achieved special distinction in the Swedish iron trade, has proved difficult to win, as it has only been awarded five times. Other medals are the silver medal, which has been given since 1822, and a second gold medal, known as the Rinman Medal, which dates from the year 1917, and which marks the centenary of the publication of *Jernkontoret Annaler*.

Jernkontoret is housed in its own building erected on a site in Kungsträdgarden. This building is ornamented externally by a frieze representing the development of Swedish iron manufactures, and contains a number of medallion portraits of Swedish metallurgists.

Riddarhuset, the Palace of the Nobility, where the technical meetings of the Institute opened on August 27th, is one of the oldest buildings in Stockholm, and is a national repository of the history and traditions of the Swedish nobility. Designed in late Renaissance style and highly ornamented, the principal feature of the building is the Great Hall, where the Institute meetings were held. The Speaker's ivory chair belongs to the early part of the sixteenth century, when it was presented to King Gustavus Vasa. The walls of the hall are almost entirely covered by the nobles' escutcheons, with arms and motto emblazoned on copper. In the olden days

of the Swedish Parliament the peers held their sessions in the Riddarhus.

The reception in the House of Jernkontoret, Mr. Jonas Carlsson Kjellberg, was an extremely pleasant function, and may be regarded as a foretaste of a programme in which the hospitality for which Sweden is distinguished carried members of the Institute through a meeting which compressed within a comparatively short time not only the reading and discussion of papers, but visits to mines and iron and steel works scattered over a wide area.

Although the band of visitors to Sweden was, for reasons referred to in what follows, comparatively small, it included a good many well-known representatives of the British iron and steel trades. In addition to Sir Peter Rylands, the President, amongst those present in Stockholm were the veteran past-President, Sir Hugh Bell, Sir Frederick Mills, the immediate past-President, Sir William Larke—National Federation of Iron and Steel Manufacturers—Mr. James Henderson, Mr. F. W. Harbord, Professor Henry Louis, Mr. E. H. Sanitor, Mr. H. B. Toy, Mr. H. Spence Thomas, and Mr. C. E. Stromeyer.

Industrial Situation.

Statistics circulated to the meeting by the British Legation in Stockholm showed that, as in other countries, the iron and steel industries in Sweden are passing through a period of severe depression. Iron ore shipments for the seven months of the present year to the end of July were only 3,450,000 tons, compared with 5,650,000 tons for the corresponding period of last year, the decline being mainly due to the reduced demand on German account. In the manufacturing sections of the industry only 33 per cent. of the ironworks are now in operation, and the Swedish market is experiencing severe competition from German, Belgian and French manufacturers.

The production of iron and steel during the first six months of the current year amounted to 640,300 tons, as compared with 640,100 tons in the corresponding period of 1925. The production embraced: Pig iron—including direct-produced castings—231,400 tons; Martin ingots and scrap castings, 174,600 tons; rolled and hammered steel and iron directly marketed, 160,600 tons; Bessemer and Thomas ingots, 37,600 tons; crucible and electric ingots, 21,900 tons; and blooms and rough bars, 14,200 tons.

Imports of iron and steel during the first six months of 1926 totalled 155,501 tons as against 127,689 tons in the first half of last year, while those of iron other than pig iron totalled 199,689 tons and 109,523 tons respectively. The principal products coming into Sweden included:—Rolled bars, shapes, &c., 52,598 tons; pig iron, 35,812 tons; rails, 25,960 tons; plates and sheets, 20,383 tons; cast pig iron pipes, 7347 tons; wrought iron tubes, 7273 tons; tin plate, 4148 tons; cold-rolled or drawn bars, 1087 tons; manganese, &c., 730 tons; and ferro-manganese and ferro-silicon, 163 tons. During the half year exports of iron ore aggregated 3,163,928 tons, as against 3,869,121 tons in the same period of 1925, while those of iron, other than pig iron, iron sponge and scrap, amounted to 67,936 tons and 81,476 tons respectively. Iron and steel exports totalled 91,682 tons only, as compared with 125,193 tons in the period January–June, 1925, the chief items in the trade being bars, 28,780 tons; pig iron, 19,341 tons; and wire rods, 10,000 tons.

It was in the famous Great Hall of the Palace of the Nobility—to which reference has already been made—that the formal inauguration of the meeting took place on the morning of August 27th. In spite of the absence of many members of the Institute who were prevented from attending from causes arising out of the coal strike, the Hall was well filled when the proceedings opened.

Mr. J. Carlsson Kjellberg, in his capacity as President of the Jernkontoret, offered members of the Institute an official but very warm welcome on behalf of the Swedish Ironmasters Association. Apart from the meetings which were to be held in the historic building in which they were assembled, he expressed the hope that much of interest would be found during the visits to scientific institutions and industrial centres which had been arranged. The last meeting held by the Institute in Sweden, which took place in the year 1898, would be within the memory of some among them. They were all aware that the Swedish iron industry from the point of view of mere size was very small, and that, as was the case in other countries, it was not flourishing at the present time. Swedish ironmasters had not, however, lost hope that better times were coming, and were doing their utmost, as were those engaged in the industry elsewhere, to hasten the revival. Efforts were being concentrated on the introduction of new and the improvement of old methods, so that a higher quality of material could be produced at lower costs than those which now prevailed. He joined with others in the hope that the coal strike in Great Britain, which had prevented many from being their guests, would soon be at an end. A settlement of the dispute would be an event of the greatest importance, not only for Great Britain, but for the whole world.

Mr. Kristoffer Huldt—President of the Swedish Association of Engineers and Architects—offered a welcome to members on behalf of that Association. Although the time at disposal was short, he said that it would be possible to show visitors something of the iron and steel and engineering industries of the country. The past-President of the Institute, Sir William Ellis, referred a year ago to the necessity of a close association between metallurgy and engineering. He concurred as to the need of that link, and was glad to acknowledge the extent to which Swedish engineers, and indeed engineers in all countries, had taken advantage of and exploited the researches carried out and the practical work done by the Iron and Steel Institute and its members. He hoped the present visit would strengthen the bonds between all those in Great Britain and Sweden whose interests lay in technical science and industrial activity.

Sir Peter Rylands—President of the Institute—in acknowledging the addresses of welcome, said that Sweden had a warm place in the minds of the ironmasters of Great Britain. She was regarded by them as the source from which the great iron industry took its rise, and he and the other members of the Iron and Steel Institute felt that in visiting Sweden they were coming among friends. As a mark of their appreciation of what had been done to make the meeting a success, the Council had that morning elected Mr. Kjellberg an honorary member of the Institute. It was a matter for regret that owing to the industrial crisis the number of members who had been able to make the journey to Stockholm was fewer than had been expected. Their hosts had realised, however, that the coal strike was a cause of great anxiety to those responsible for the operation of British industrial establishments, and in the case of the iron and steel industry the lack of coal had gradually brought British works to a standstill. It was for that reason only that many of those prominently identified with the British industry had been forced with great regret to abandon their intention to visit Stockholm and take part in that meeting. A feature of the industry in Sweden which was worthy of comment was the interest which the Royal House had always taken in its development since the era of that great king, Gustavus Vasa. The present King had shown his interest in the industry by extending to the members of the Institute a gracious invitation to meet him that afternoon. It was a disappointment to them that his Majesty would be unable to hold that reception owing to the serious illness of the Queen, and in these circumstances he would ask members to join with him in sending a telegram to his Majesty expressing their sympathy with him in his present time of trouble and anxiety.

Mr. Kjellberg said that he had been asked by the King to express his deep regret that, for the reason to which reference had been made, he was unable to receive members of the Institute, but the King had made arrangements for the Palace to be visited and the relics and collections to be inspected.

The History of Jernkontoret.

The meeting then proceeded with the reading and discussion of papers. The first contribution being one by Mr. Emil Kinander, on "The History and Organisation of Jernkontoret," of which we give an abstract.

After emerging from the stage of a domestic industry the Swedish iron industry very early became dependent on the State, and a subject of its special interest. It may be said that the industry was built up on a system of State privileges and concessions. The founder of modern Sweden, Gustavus Vasa, was, on the subject of ironmaking, as in so many other respects, a far-sighted man. His work was continued by his son Charles IX., the founder of the mining centres in Värmland, and by his grandson Gustavus Adolphus, who, in spite of his numerous and long wars, found ample time to interest himself in the promotion of peaceful enterprise. It was during these times that many foreign ironmasters and workmen immigrated into Sweden, and were received here with a view to improving the making of iron. Many of these foreigners were of that Walloon stock who in later generations proved thrifty, enterprising, and highly skilled workmen.

Under the regency of Axel Oxenstierna, during the infancy of Christina, the daughter of the great monarch, and in the time of her own reign, the iron industry of Sweden gained greatly in strength. Indeed, the first complete ordinance for the mines and ironworks dates from that time, namely, 1649. Throughout the later part of the seventeenth century the iron industry continued to develop in a marked degree. New blast-furnaces and forges were erected, new or improved arrangements and methods of manufacture were introduced. The increased production was, however, accompanied by a gradually growing uneasiness about the market. Amongst the untavourable circumstances the one which caused the deepest dissatisfaction was that the iron industry had fallen into the hands of a few men only, who took advantage of the conditions to depress the prices, or at least to impose harsh terms for advances to the ironmasters, and many of these lenders of capital were agents, acting on behalf of foreign merchants.

The commercial agent Andreas Backmansson, ennobled in 1743 under the name Nordencrants, is regarded as the founder of Jernkontoret. In that year he submitted to the Secret Commission a memorandum on the iron industry, and after preliminary discussions between him and the so-called "Iron Commission," consisting of three State councillors and three works owners, the Board of Trade was ordered to arrange that for every iron district or *bergslag*, the owners of the forges within its boundaries should elect one or two delegates to meet in Stockholm in the beginning of 1744 to decide "on all such matters that should be necessary for the preservation of the interest of the iron districts and the interest of the realm depending thereon."

This new "Ironmasters' Parliament," or *Bruksriksdag*, consisting of about forty delegates from the iron districts, assembled in the capital in the beginning of 1744 and entered into negotiations with the previously mentioned "Iron Commission," for which purpose the delegates from amongst themselves selected twelve deputies. The negotiations ended on March 17th, 1744, and resulted in an "agreement between all works owners" being accepted "for further discussion and approval by their colleagues at home." This agreement may be regarded as Jernkontoret's earliest charter of foundation, from which the leading features may be quoted.

Certain minimum prices were determined for the sale of the different kinds of iron. In order to maintain the level of those prices the ironmasters agreed to establish an association, with headquarters at Stockholm and directed by certain delegates, which association was to buy all iron that could not be placed on the market at acceptable prices, and hold it until it could be advantageously sold. In order to ensure the necessary funds, each ironmaster was to pay one daler (copper coinage) for each skeppund of iron manufactured, one-half in May and one-half in September, and further, during the first years of the Association's existence, to allow three daler (copper coinage) to remain with the Association for each skeppund of iron sold to it. The agreement, which was signed by thirty-two owners of works, was to be valid for three years.

The time immediately following this agreement was chiefly occupied in efforts to increase the number of associated works. Several difficulties were encountered, above all in procuring the capital necessary for the first purchases of iron.

According to a decision at a meeting in February, 1747, a large number of ironmasters met in Stockholm in the autumn of that year at the opening of the parliamentary session, and renewed their appeal to the Government for aid to the iron industry. The whole question was referred to the Secret Commission of the Parliament, where it was taken charge of by the deputies for commerce and manufacture, amongst whom were the Secretary of State, C. G. Löwenhjelm, and Councillor Lars Benzelstierna, of the Board of Mines and Ironworks, who had both been strongly active in establishing the Association; also the influential Commercial Councillor Thomas Plongren, a merchant highly interested in the iron trade. The economic basis having been established by the lowering of the interest of the State Bank to 4 per cent. for loans against iron as security, and by a special ordinance against over-production, Plongren personally worked out a memorandum "regarding the establishment of an Association of Ironmasters" (*Jernkontor*), which was approved by the above-mentioned deputies and by the Secret Commission on December 3rd. On December 29th it was sanctioned by the King and issued as "Official Rules for Jernkontoret."

The Royal ordinance of December 29th, 1747, mentions as the chief motive for establishing the Association of Ironmasters, in accordance with the earlier projects, the necessity of extricating the iron trade from the grip of foreign capitalists and their influence on the prices. The Association would step in and with the aid of its funds save Swedish sellers of iron from the necessity of selling their goods at an unfavourable time and at too low prices. This aim was to be achieved by granting the seller the right to obtain loans from the State Bank against iron as soon as it was weighed and accepted at the wharves up to seven-eighths of its value and at only 4 per cent. interest. What he had thus paid as interest to the bank he was entitled to have refunded without delay from Jernkontoret. In order to procure the necessary funds for the Association, the buyer—not the seller, as previously determined—had to pay to the Association one daler (copper coinage) for each skeppund of bar iron bought. If necessary for bettering or regulating the prices, the Association should itself appear as buyer.

Within the first years of Jernkontoret's existence new forms of support to the iron industry had already begun to appear. Further rules made in 1751 permitted that the funds of the Association, as far as they were not immediately needed, could be deposited in the bank or utilised for the granting of loans to private persons against certain kinds of securities. Thus commenced Jernkontoret's lending functions, which thereafter continued and still continue. But it soon became apparent that reasonable selling prices and cheap loans were not sufficient. It was found that the technical side of ironmaking also was in need of development, and thus the question of Jernkontoret's technical mission became prominent.

Originally Jernkontoret, as will be noted, was intended exclusively for the support of the bar iron trade. But by the granting of assistance in 1749 to a manufacturer of finished iron goods the question of affiliating all such manufacturers with the Association was soon brought to the fore. By the Royal Ordinance of September 22nd, 1752, it was allowed as a temporary measure and by way of experiment that certain manufacturers of heavier finished iron ware should be admitted to the Association against special dues, and in 1757 extensive changes in Jernkontoret's activity were applied

Jernkontoret's activity is nowadays conducted on practically the same lines as were laid down during the first period of its existence. Changes indeed occurred due to different conditions at different times, but in general these were of no great consequence. However, Jernkontoret has gradually developed and strengthened its leading position in the iron industry.

Since the latter part of the nineteenth century there have been arranged, in connection with the general meetings, technical meetings for discussion of questions of interest for the iron industry, generally called "Jernkontoret's technical meetings."

It has already been mentioned that Jernkontoret's activity during the first period of development was directed on two principal lines: direct loans to works owners in need and support to institutions of importance for the iron industry. These two principal lines were also accentuated in the rules of 1769, 1868, and 1894, mentioned above.

Regarding the practical application of these rules the journeys to the "Fastingen" market at Kristinehamn had been one of the principal forms for Jernkontoret's support to works owners desiring assistance. Direct purchases of iron by Jernkontoret seem to have occurred for the last time in 1780. In 1808 it was, however, decided by the Society that until the next meeting the journeys to Kristinehamn should be discontinued, and at this meeting in 1811 their cessation for the future was decided. Sporadically such journeys have, however, occurred later.

When these journeys ceased the form of direct loans had already long become the principal method for supporting works owners. The conditions for such loans in the rules of 1769, previously briefly referred to, have later undergone changes from time to time. At present they are as follows:—

Those special loans which owners of works, admitted to Jernkontoret, in virtue of the part ownership, are entitled to obtain are "advance loans" and building loans. Advance loans against approved security may be granted to an amount of 5 kronor for each centner of iron for which the works is part owner in Jernkontoret. The interest is now 4½ per cent., and the loans are repayable either after certain fixed periods, not exceeding twelve months, or after notice, not exceeding three months. They may, however, be renewed on falling due.

Building loans are granted, likewise against security approved by the board, to an amount representing at most half the cost of the building in question, but not exceeding 100,000 kronor for each part owner. Interest on such loans shall be paid at 6 per cent. per annum. The loan shall be repaid in equal instalments, not less than one-fifth every year, commencing the year after that in which the building shall have been completed. The total shall, however, be repaid not later than eight years after the loan is granted. The amount of building loans may in no instance exceed 1,000,000 kronor.

To be entitled to obtain such loans, the stipulated dues, 2½ öre yearly for each centner of iron introduced, must be duly paid. In addition to the above privileged loans a part owner in Jernkontoret is entitled to obtain further loans against approved security to such extent as Jernkontoret's means may allow and at an interest which during recent years has been fixed at ½ per cent. lower than ordinary bank interest.

Jernkontoret's other funds must be invested according to conditions laid down by the Society.

Apart from the purchase of iron and direct loans there was, as mentioned above, at the disposal of Jernkontoret a special fund called "the licence fund," out of which were paid export bounties on the sale to foreign countries of manufactured goods. This branch of activity was, however, concluded in 1824, when

the fund on Jernkontoret's request by decision of the King was delivered over to the Board of Trade, the export bounties having ceased in 1820.

The policy of engaging prominent men for the technical advancement and control of the iron industry which Jernkontoret had adopted during the first decades of its existence, together with the purchases of iron, direct loans, and export bounties, was naturally still further developed when the Association in 1769 had gained its independence.

In 1902 the question was raised regarding new arrangements of Jernkontoret's technical staff, and a committee was appointed to consider the matter. The principal question, whether a technical staff was still needed and useful to the Swedish iron industry, was answered by this committee to the effect that as far as they understood the matter, the opinion that such was the case could scarcely be disputed. The committee reports on this subject :—"The circumstances have in this respect certainly changed in that the works owner exerts himself more than previously, and in order to hold his own in competition he must seek to engage the best obtainable technical men. On the other hand, the technical questions have grown in extent and they vary to such a degree that the industry rarely, if ever, can by itself find a sufficient supply of men qualified in all branches. It may further often be difficult for the engineers to follow developments closely enough and to utilise them advantageously. Under these circumstances it is desirable that Jernkontoret shall undertake in the future to serve its part owners in this respect."

As to the manner of meeting the requirements, the committee endorsed the opinion already expressed on different occasions regarding the unsuitability of a fixed staff of technical officials, and recommended that technical experts should be engaged only in so far as especially able men could be obtained for the more important branches of the industry. The committee, however, also discussed the question of the then existing need of experts. The report recommends as most desirable the realisation of the plan approved by the Society in 1856, but at that time not carried out, to appoint a chief of Jernkontoret's technical staff. The committee considered it highly desirable that Jernkontoret should engage some person of especially prominent technical ability and practical experience capable of uniting all the technical experts within Jernkontoret. He should further follow technical progress, act as technical adviser to the board, and, if possible, also as expert on questions regarding iron and steel. For this official was suggested the title chief engineer.

After consideration of this report by the Society in 1903 the following decision was arrived at :—

Without organising a permanent staff of technical experts, there should be attached to Jernkontoret until further notice, and provided suitable persons can be found, one chief engineer, two metallurgical engineers, two mechanical engineers (among which five engineers at least one should be expert in questions regarding combustion), one mining engineer, one expert on peat, and three master forgemen, together with a suitable number of stipendiaries. The experts should principally serve the members of the Society and the board of Jernkontoret as advisers. A sum of 70,000 kronor was granted for :—

(*a*) Salaries to those who, according to contract, are engaged as engineers, master forgemen, or as technical assistants of other kinds to act as advisers to the members of the Society or Jernkontoret's board.

(*b*) Scholarships to young men who, after training in technical schools or in other ways, have gained technical education in the iron industry, and apply themselves to metallurgy, mechanics, or mining.

(*c*) A travelling scholarship, and

(*d*) Prizes to persons who, whether they obtain salaries from Jernkontoret or not, have distinguished themselves through useful inventions or other practical activity in the iron industry.

Of the sum of 70,000 kronor granted, 55,000 kronor were estimated as salaries for technical experts, the chief engineer included, and master forgemen, 6000 kronor for stipendiaries (holders of scholarships), 4000 kronor for travelling scholarships, 2000 kronor for prizes, and the remaining 3000 kronor for sundries.

As first holder of the new position of chief engineer at Jernkontoret was chosen the chief engineer of the Fagersta Steel Works, J. A. Brinell, who, through his discoveries and authorship, had gained a reputation as one of the foremost amongst the metallurgists of the time. He entered his position in 1903 and remained in Jernkontoret's service till 1914, when he retired on a pension. He was succeeded by A. Wahlberg, also previously chief engineer at Fagersta. Brinell died in 1925.

Closely connected with the grant for the technical staff there is another group of grants for technical experiments. The support of metallurgical research is also the object of Jernkontoret's grant—at present a maximum of 6000 kronor a year—to the Metallographic Institute erected in 1920, the first director of which is Professor Carl Benedicks, one of the honorary vice-presidents of the Iron and Steel Institute.

Regarding the technical activity of Jernkontoret, an additional arrangement has been adopted during the current year, from which good results are expected. The board accepted a proposal made by the editor of *Jernkontorets Annaler* (Mr. A. Grabe) to arrange in connection with Jernkontoret permanent technical committees for the different branches of the iron industry, in accordance with the arrangements in several foreign countries.

In addition to these new spheres of Jernkontoret's technical activity mention should be made of its co-operation in providing a satisfactory training of technical men for the iron industry.

That Jernkontoret has been able for so long to exist and work for the benefit of the Swedish iron industry is mainly to be attributed to the circumstance that it has been fortunate in obtaining good executive deputies and collaborators. The relations between the Society and Jernkontoret have been characterised by a confidential collaboration, and the position of delegate to Jernkontoret, or as deputy to assist in the audit, has always been appreciated as a proof of the estimation of the Society.

Sir Peter Rylands, in proposing a vote of thanks to the author, said the paper was a most interesting record of a wonderful Institution to which Great Britain was unable to show any counterpart. The paper would constitute a very valuable addition to the "Transactions" of the Institute.

IRON INDUSTRY OF SWEDEN.

Mr. Axel Wahlberg—chief engineer, Jernkontoret—presented a paper by himself and Professor Arvid Johansson, dealing with "The Development of the Swedish Iron Industry During the Last Thirty Years." It is a long paper, but in what follows we have endeavoured to present its principal features.

The Swedish iron industry is mainly still based on the ores of Central Sweden, which are very low in phosphorus and sulphur. Thus the blast-furnace burdens of the steel-producing works still contain the old well-known ores : Bispberg, Dannemora, Dalkarlsberg, Norberg, Nyäng, Persberg, Taberg, Stripa, Striberg, Ställberg, &c. Of ores from the north of Sweden it is only the particularly pure Tuolluvaara ore that during the last twenty-five years has to a limited extent been used by ironworks in Central Sweden. The principal ores for Swedish Lancashire iron are still the ores from Dannemora, Norberg, Striberg, Stripa, Vintjärn, &c.

In the course of time there had accumulated at our mines large quantities of waste low-grade ore—40 per cent. iron or less—which it had been impossible to utilise owing to their low percentage of iron. By combining the concentration of these low-grade ores with agglomeration of the fine concentrates the problem was solved, through the efforts of Dr. Gröndal, in the beginning of the century. The ores are now utilised as follows : —They are crushed in a stone-breaker, ground in a ball mill, treated by wet magnetic separation, and the fine concentrate is agglomerated by briquetting or sintering. The last processes are, however, as a rule carried out at the blast-furnaces. For the last fifteen years it has been usual to keep the iron between 58 and 64 per cent. in the concentrates consumed in our charcoal furnaces when making pig iron for conversion into the higher qualities of steel. These old ore dumps are, however, now practically all used up, and concentration is limited to the lean ore obtained when mining for lump ore. The iron content of the latter is generally 50 to 60 per cent. As a matter of fact, lump ores still form the bulk of the ores used.

Since the earliest period of our iron industry the demand for charcoal has been met by burning in heaps. About 1900 the practice of carbonising in ovens began to gain ground, and during the last two decades about 10 per cent. of the charcoal supply has been produced in ovens with the recovery of by-products. But the original methods of carbonising in heaps are still used, with some modifications. However, horizontal heaps are being replaced by vertical heaps.

In the years following 1900 there was considerable activity in the construction of charcoal ovens, and the development aimed both at obtaining higher yields of charcoal and by-products, as well as improving the quality of the charcoal. The value of the by-products produced in 1924 was about 2,300,000 crowns, whereas the corresponding figure for 1900 was only 270,000 crowns.

In 1923, according to published statistics, there were produced in Sweden 52,148 tons of ordinary electric pig iron with a consumption of energy of 132·2 million kilowatt-hours and 1,331,464 hectolitres of charcoal, or 2540 kilowatt-hours and 25·5 hectolitres for 1 ton of pig iron. On a yearly production of, say, 500,000 tons of pig iron, exclusively electric, we should save 18 million hectolitres of charcoal, that *is*, 18 million crowns, reckoning the price at 1 crown per hectolitre. If the electric power could be obtained at a price of 0·8 öre per kilowatt-hour, the cost of the power would amount to 10 million crowns, and the real saving to 8 million crowns, apart from interest and depreciation. After allowing for these items the net saving would probably amount to 4·5 to 5 million crowns.

Pig Iron Production.—The development of Swedish pig iron production during the last twenty-five years is characterised by the introduction of the electric furnace, where a certain portion of the charcoal has been replaced by electric energy transformed into heat.

The inside dimensions of the ordinary blast-furnaces are in the main unchanged, except that the diameter of the hearth has been increased a little and the stack has been lowered somewhat, resulting in a lower bosh.

Dimensions, &c., of Swedish Charcoal Blast-furnaces.

	Blast-furnace from about 1890.	Built 1915.
Inside height	15·6 m.	18·0 m.
Diameter of bottom of hearth	1·4 m.	1·9 m.
Diameter of bosh	2·8 m.	3·0 m.
Height to top of bosh	4·6 m.	3·5 m.
Cubic capacity	66·4 m.³	89·7 m.³
Weekly production	115 to 130 tons	175 to 200 tons

The treatment of the ore depends on the condition in which it arrives. Lump ore is roasted as formerly in a Westman roasting kiln, fired by blast-furnace gas, in order to remove sulphur and make the ore more reducible. Crushing to size suitable for roasting (100 mm. to 125 mm.) is increasingly carried out at the mine, doing away with the former breaking by hand at the blast-furnace. After roasting the ore is further broken to a size of 20 mm. to 40 mm., to be suitable for the blast-furnace. In modern furnaces the roasted ore goes from the roasting kiln to large ore bins, then to the crusher, and then, by automatic hoist and distributor, to the small ore hoppers on the top of the furnace.

The agglomeration of the fine concentrates, as before stated, is done either by briquetting or sintering. For briquetting, the Gröndal method is used. No special binding medium is used. By this process of briquetting the sulphur content of the concentrates is reduced considerably. In concentrates with an excess of silica it is easy enough to reduce sulphur from 0·2 per cent. to less than 0·01 per cent. The cost of briquetting soon proved, however, to be higher than was at first calculated. It necessitated a great deal of manual labour, and when during the war the cost of labour, and especially of fuel, increased very much, attention was directed to the Greenawalt sintering method. By this method it was not necessary to make briquettes, and it was possible to use as fuel the charcoal screenings, which up till then had been of practically no value. A change in the method was made, within the last few years, in such a way that circular pans holding 1 ton are used instead of the large rectangular pans holding 3 to 4 tons of concentrates, and this has resulted in cheaper building costs without any increase in running expenses. The sintering of concentrate seems as effective as the briquetting process, both as regards removal of sulphur and the suitability of the product for the blast-furnace. As the sintering process does not necessitate the use of a so uniformly fine crushed material as the briquetting, it has during the last years to some extent also been applied to the desulphurising of crushed, but not concentrated, lump ore. In this way a relatively cheap sintered product is obtained, and all the accompanying gangue is melted with the ore in the furnace. Both the briquettes and the sinter are crushed to a somewhat coarser size than the lump ore before charging in the furnace.

The proportion of briquettes or sinter to lump ore used in the charge depends on the supply and character of the concentrates, the percentage of iron in the burden, &c. The usual amount of briquettes or sinter for steel works blast-furnaces is from 0 up to 30 per cent. of the burden. Their use promotes smooth running and decreases the charcoal consumption by about 10 per cent. The percentage of iron in the burden is kept at about 50 to 55 per cent. If a richer burden is used there is a decrease in the protection afforded by the slag when passing the tuyeres, especially for such burdens where the main ores are not self-fluxing, and where the slag is formed by fluxing different ores with each other or with limestone.

The blast-pressure in the charcoal furnaces is still kept at 60 mm. to 100 mm. mercury gauge. The old water or steam-driven blowing engines have in many cases been replaced by electrically driven rotary blowers or high-pressure fans. The heating of the blast is done, as formerly, in hot blast stoves with horizontal cast iron pipes, heated by blast-furnace gas. The thermal efficiency of these stoves is hardly 30 per cent., and therefore efforts are being made to improve on this in some way. But it is not intended to increase the temperature of the blast, because a blast temperature of not over 400 deg. Cent. has been found to give the best pig iron.

Pig Iron Production by Electric Power.—With the rapidly increasing use of electric energy at the beginning of the century the idea was conceived of replacing the charcoal used in the blast-furnace by electric energy transformed into heat. The only charcoal needed would then be that necessary for the reduction of the iron. A small experimental furnace for this purpose was designed by A. B. Elektrometall, and built in Domnarfvet in 1907, with the result that, at the expense of Jernkontoret, a full-size furnace was erected at Trollhättan in 1910. The Government power station at the same place furnished the necessary electric power.

The furnace fulfilled all expectations. Thus a high-quality charcoal pig iron could be produced with a charcoal consumption of only about 25 hectolitres, and a power consumption of about 2500 kilowatt-hours per ton of iron made. It was built for an energy consumption of 2000 kilowatts, and was provided with four carbon electrodes, 660 mm. square, inserted in a slanting direction towards the centre of a cylindrical hearth. From the top of the hearth rose a vertical shaft, into which charcoal and ore were charged with the usual apparatus, and became preheated by the ascending gases, formed by the reduction. After passing through the shaft, part of the gases were returned to the hearth by means of a fan, in order to cool the roof around the electrodes and also to increase the reducing action of the carbon monoxide. Later furnaces have been built with six electrodes of a diameter of 600 mm., and at one place Söderberg electrodes are used with good results.

The pig iron produced proved to be of excellent quality, both for use in the Lancashire hearth and for making high-quality steel in the open hearth. Judging from several circumstances, it is likely that the production of electric pig iron will develop, especially in the north of Sweden, where very cheap power is to be had and where there is a good supply of charcoal and iron ores suitable for this process.

The lump ore used in the electric furnace is charged unroasted and must on this account be as free from sulphur as possible, especially as in this process less sulphur is taken up by the slag than in the ordinary blast-furnace. Briquettes and sinter are also used. A burden high in iron runs better than a burden lower in iron.

Some Figures Relating to Electric Furnaces.

	The experimental furnace at Trollhättan	Furnace of more modern design.
Interior height	10·8 m.	10·6 m.
Diameter of the hearth	4·0 m.	5·3 m.
Diameter of the shaft	2·3 m.	3·2 m.
Volume of the smelting chamber	12·5 m.³	35·0 m.³
Total volume	38·0 m.³	92·0 m.³
Kilowatts	About 2000	About 4000
Production per twenty-four hours	18 to 20 tons	About 37 tons

There are now fourteen electric furnaces in the country.

The blast-furnace gas, in excess of what was required for roasting kilns and hot blast stoves, was formerly used mostly for raising steam for blowing engines, hoists, hammers, &c., but at isolated blast-furnace plants using water power the excess gas was generally wasted. Since the beginning of the century the gas has also been used in open-hearth furnaces, briquette furnaces, and annealing furnaces. It has been proposed to use the excess gas for generating power direct, as in other countries, but in view of the development of our water power and electric transmission it was found, as a rule, more advantageous to use the gas for heating purposes. There is only one place, Forsbacka, where gas engines are used.

Production of Steel.—The development of Swedish steel-making during the last twenty-five years is marked by the decline in the Bessemer process, whereas the open-hearth process has largely expanded and electric steel-making has come into use to some extent.

The decrease in the use of Bessemer steel is partly due to the fact that open-hearth steel has proved better for many purposes, but the principal reason is that the cost of producing Bessemer steel has increased, on account of the greater charcoal consumption in the blast-furnace, more expensive ores, and greater waste in production. Owing to the small charges there is also a larger amount of scrap in proportion to the weight of cropped ingots obtained.

The Swedish open-hearth furnaces at the beginning of the century had a capacity up to 10 tons, and there were very few furnaces that could handle a larger charge. The tendency has been towards larger furnaces, but not in the same degree as abroad. For furnaces with acid linings 15 tons is the maximum, and for basic furnaces 25 tons. The reason why acid furnaces do not take larger charges is the quality. Also for basic furnaces producing high-class steel 15 tons is rarely exceeded, while for cheaper material the limit of 25 tons is chosen solely for the ease of manipulation.

As to the furnaces, the hearth nowadays is made somewhat longer than formerly for the same size of charge. Through this the heat is more easily transmitted to the charge, and the oxidation is more rapid, which is of importance, because the small supply of scrap necessitates large amounts of pig iron. A more rapid oxidation is also obtained by placing gas and air ports side by side instead of the air ports above the gas ports. Less sulphur is also supposed to be taken up from the gas, when the ports are placed side by side, for the reason that the gas has been practically all burned before it comes in contact with the metal.

Where quality steel is produced a cold charge is always used, which makes it possible to sort carefully the pig iron and scrap suitable for the different kinds of steel made. The charge is tapped when the desired carbon content has been reached. Recarburisation is not used. Additions of ferro-manganese, &c., are always made in the furnace, except for cheap steel, when the ferro may be added in the ladle.

The steel is cast into ingots usually 250 mm. by 300 mm. in cross section. In exceptional cases the dimension 400 mm. by 400 mm. is used.

The production of steel in electric furnaces has never attained importance in Sweden. We believe that, by means of the older methods for steel making, we are able to produce a steel quite as good as any electric steel. But, of course, electric furnaces are in use for the production of some high-alloy steels that are difficult to produce in open-hearth furnaces. These are smaller than open-hearth furnaces, being of 1 to 4 tons capacity ; usually they are electric arc furnaces of the Rennerfelt or Héroult type, but a few works use induction furnaces. All material is charged cold, except in one place, where there is a larger electric furnace installed for refining basic Bessemer steel.

Annealing of Steel.—During the last decade the question of steel annealing has become more important for the Swedish steel works, both in regard to carbon tool steel as well as special steels of different kinds. Different furnace builders have tried to solve the by no means easy problem of constructing a suitable furnace, giving a uniform heat, easy to control and to regulate. Steel castings and heavy forgings are annealed in a furnace with a movable bottom, running on wheels or on rollers. The furnace is fired at the end opposite to the door, or through the roof by means of a Weardale burner. The annealing is, as a rule, of a normalising character.

At one place there is an electric annealing furnace installed. The steel is placed on a car, covered with a brick-lined hood and electrically heated by nichrome spirals embedded in the linings of the car and the hood. The furnace gives a uniform temperature and is particularly easy to handle because of the automatic regulation of the heat. It is likely to be specially used at such works where blast-furnace gas is not available.

The annealing is controlled by the Brinell test. Surface decarburisation, which is difficult to avoid when soft annealing, is to a large extent prevented by the proper embedding of the steel in cast iron turnings or some other protecting material. It is now also usual to pickle the steel when it is essential to avoid decarburisation.

As far as we can judge the annealing at our steel works is nowadays carried out in the very best way possible, principally thanks to the excellence of our annealing furnaces, which have been independently developed in Sweden, but also on account of our thorough experience in the practice of annealing itself.

Market Conditions.—What are the future prospects for our old

renowned iron industry? Our industry has probably never been in such a critical situation as now; but, notwithstanding this lamentable fact, we expect and hope that our iron industry will not only survive, but that it will expand so far as high-quality production is concerned.

The prospect of once more building up a paying production of ordinary steel and iron depends on many things, and especially on whether we get a reasonably protective tariff or not. We call to mind that the wealthy United States protects its steel industry, which works under very favourable conditions, with an import duty of about 82 Swedish crowns per ton on ordinary merchant iron, while the corresponding Swedish import duty is 25 crowns, or less than a third. A higher import duty in Sweden would seem reasonable and would improve the situation.

The best of all reasons for a more optimistic view as to the future of our special steel industry is that we believe that there is always likely to be an increased demand for high-class steel in the world, and for the production of such steel we are well fitted because of our pure and suitable iron ores, our charcoal supply and our cheap water power, which can be used both for producing mechanical energy and for metallurgical purposes.

Finally, we have our particularly well-developed educational system of the training of our metallurgists, and with the help of the teachers and laboratories of our mining schools, as well as the Government Testing Institute, the Metallographic Institute, and last, but not least, Jernkontoret, we hope that our iron and steel industry will ever maintain a strong position in Sweden and still be respected all over the industrial world.

Sir Peter Rylands said it was not proposed to discuss this valuable contribution, which was a record of an interesting period of progress in the iron and steel industry, for which warm thanks were due to the authors. He would, however, remind the meeting that in a paper which Mr. Wahlberg contributed to the Institute at a meeting in London in 1901, he disclosed for the first time the Brinell method of testing for hardness, which had since become a part of the regular practice in iron and steel works. An account of the Brinell method appeared concurrently with the reading of the paper by Mr. Wahlberg in the *Jernkontoret Annaler*, the periodical published by the Swedish Ironmasters' Association since the year 1817.

SWEDISH MINING INDUSTRY.

Professor W. Petersson then read a paper on "The Development of the Swedish Mining Industry During the Last Twenty-five Years." We give below an abstract of that part which deals with technical matters.

The Swedish iron ore deposits occur principally within two separate districts, one in the central part of Sweden, known as Mellersta Sveriges Bergslager (mining district of Central Sweden), and one in the most northern region of the country, Lapland.

The phosphorus contents of the Swedish iron ores varies considerably. A very large percentage contains only minute quantities, below 0·010 per cent., of this element, and these are the ores which form the principal raw material for the famous high-quality Swedish iron and steel. The ores high in phosphorus are mostly exported.

The contents of sulphur are comparatively low, as a rule well below 0·05 per cent. in those ores used in the Swedish iron industry. Most of the export ores are also unusually free from sulphur. The manganese contents are likewise generally low, though some few thousand tons of ore containing about 10 per cent. of manganese are mined yearly, and with the few exceptions mentioned above, the ore deposits are practically free from or very low in titanium.

Vanadium is not found in the titanium-free ores, but in those which contain titanium even in small quantities vanadium is invariably found in quantities sometimes very small, sometimes up to about 0·2 per cent.

The percentage of iron in the Swedish rock ores is as a rule rather high, and this is specially the case with the Lapland ores. It has been estimated that the iron ores of Sweden contain on an average about 60 per cent. of iron, though all grades between 50 and 70 per cent. are found. For comparison it may be mentioned that the corresponding figure for the French minette ore is about 33 per cent., for the Lake Superior ores of the United States 51 to 52 per cent., undried, and for all British ores an average of about 30 per cent.

In addition to the rock ores there also occur in the youngest formation the Quaternary, iron ores, but of a quite different type, namely, soft bog and lake ores, which, by the way, in many instances are still being formed in lakes and swamps. These deposits, which in older times played quite a considerable part in the Swedish iron industry, are nowadays employed in but very small quantities for the production of foundry pig iron, principally in the "läns" of Jönköping and Kronoberg. In 1924 the total output of lake ore raised in Sweden was not more than 6358 tons, while 6,499,730 tons of rock ores were produced during the same year.

The iron mines are, as a rule, not very deep. The largest of all, namely, Kiirunavaara, is still mainly in the quarrying stage. The deepest level at which mining is now carried on in Swedish iron ore mines is about 400 m. below the outcrop of the ore. In none of these places does the ore differ in composition from that of higher levels, nor has it been found as a rule that the dimensions of the ore deposit decrease in depth. On the other hand, a number of minor deposits have pinched out at comparatively small depths.

In connection with the change to modern methods of mining and the increase of the production there has been an endeavour to centralise the mining as much as possible. In former times the shafts were generally placed in the ore itself, but nowadays they are as a rule placed in the country rock, and so far from the ore that they are undisturbed by running ground which may occur in the workings. They are placed with a view to serving several mines at the same time, the above-mentioned improvements in the drilling technique having brought about that the driving of long levels does not present such great difficulties as formerly. The arrangements for the loading and transport of the broken rock on underground tracks has undergone important improvements during recent years.

The loading of the broken rock underground, which by underhand stoping was carried out from the bottom, is in all new mining methods carried out automatically through chutes arranged so high up in the levels that the rock may run directly into the cars placed underneath. The transport underground is on tracks, hand transport being used for shorter distances and smaller quantities, and locomotives driven electrically or by compressed air for longer distances or larger quantities. For hoisting most of the mines have guide hoists or skips with a speed of 3 m. to 5 m. per second. The transport of men is mostly effected by means of guide hoists with safety arrangements.

Ore Treatment.—In most of the smaller iron mines the separation of the valuable minerals from the waste material is carried out simply by hand sorting and hand picking in rock houses erected in the immediate neighbourhood of the shaft head. The small ores (*syltan*) were formerly treated by washing and picking by hand.

Since 1884, however, the washing process in most mines working magnetic iron ore has been superseded by coarse separation with cobbing magnets (*malmskiljare*). Besides the Wenström ore separator, which was the first to be employed, several more modern coarse ore separators have come into use in recent years, such as the Landén-Josephson, the Vulcanus, the Gröndahl, and several others.

At mines with magnetic ore mixed with hematite ores jigs are now commonly used for separating the hematite from the non-magnetic tailings coming from the magnetic separators.

Methods of Exploring for Ore.—As most of the Swedish iron ores contain magnetite, methods of discovering ore deposits by the deflection of a magnetic needle in the vicinity of magnetic ores have long been in use. On the introduction of the electrical ore finding method of Daft and Williams in 1907 in Sweden, ore finding by electrical means has been the subject of a lively interest, and at present two Swedish ore-finding methods are worked out which have been largely used in Sweden as well as in foreign countries, especially in America and South Africa. One of these methods is based on the investigation of the potential in an electrical field by tracing equipotential curves or measuring differences in potential between different points—the potential method; the other method—the electro-magnetic method—is based upon investigations of the direction and intensity of an electro-magnetic field.

While the use of magnetic measurements is possible only for magnetite or magnetic pyrites, the electrical methods are suitable for all kinds of deposits which have an electrical conductivity different from that of the surrounding rock—that is, for practically all ore deposits. By means of the electrical ore-finding method large deposits of copper, pyrites, zinc and lead ores have, for instance, been detected in the north of Sweden in the neighbourhood of Skelleftea.

In addition to the magnetic and electric investigation methods, prospecting by means of diamond drilling has been extensively resorted to in Swedish ore districts.

Professor Henry Louis expressed the thanks of visiting members to the authors of the paper presented for the excellent account given of the mining and metallurgical industries of Sweden. Referring to Professor Petersson's contribution, there were, however, one or two points on which further information would be welcomed. Reference had been made in quite brief terms to the methods of magazine mining or shrinkage stoping. He—Professor Louis—had always been under the impression that that method, if not actually devised in Scandinavia, was largely developed by Scandinavian mining engineers. He had personally seen it in operation at Grängesberg and Ammeberg, but it would be of great interest to have a statement concerning the origin of that method and its development. There was a good deal of difference of opinion as to the advantages of this particular system, and he would like to know if it was still being used at Swedish mines. It was an important question as regarded general mining practice. Another point on which additional information would be appreciated was as to the methods of electric ore finding, which he knew had been developed to a considerable extent in Sweden. There was a difficulty in employing that method arising from the fact that similar indications were given for underground water channels as for veins of ore. He would like to know if the doubts due to this cause had been solved, and to have additional details as to the precise methods employed and the results obtained.

Professor Petersson said he would consider carefully the points raised by Professor Louis, and endeavour to give the information which it was desired should be added to the paper.

A vote of thanks was accorded to the author of the paper.

The other contribution on the agenda, which was a paper on "The Effect of Nitrogen on Chromium and Iron Chromium Alloys," by Mr. F. Adcock, of the National Physical Laboratory, was taken as read, and the meeting was adjourned until the following day. An abstract of this paper is given below.

THE EFFECT OF NITROGEN ON CHROMIUM AND SOME IRON-CHROMIUM ALLOYS.

Some iron-chromium alloys prepared in a carbon ring furnace were found to be contaminated with nitrogen. In view of the importance of this fact in connection with other work, an investigation was made into the conditions under which nitrogen is absorbed by iron, chromium, and iron-chromium alloys. The microstructures and hardness of alloys containing nitrogen were also studied.

Samples of pure iron, chromium, and iron-chromium alloys were treated with nitrogen for thirty to fifty minutes by passing the gas over the surface of the metals maintained in the liquid state in a high-frequency induction furnace. The microstructure and hardness of the alloys were observed and confirmed by reference to a series of less pure iron-chromium alloys containing nitrogen, made in the carbon ring furnace.

Structures of the martensitic and pearlitic type similar to those found in carbon steels are produced in the pure iron-chromium alloys by the addition of nitrogen. The hardness of iron-chromium-nitrogen alloys (region 12 per cent. chromium) exhibiting the martensitic type of structure is modified on heat treatment.

Nitrogen is readily absorbed at high temperatures by iron-chromium alloys in the solid state, and the penetration of the material by nitrogen appears to be especially rapid in the vicinity of crystal grain boundaries.

Members and ladies accompanying them were entertained to luncheon at the Restaurant Hasselbacken, by the Swedish Society of Engineers and Architects, and visits were afterwards made to the Royal Palace and other places of interest in the city.

In the evening a banquet, which was largely attended, was given on the invitation of Jernkontoret, at the Grand Hotel Royal. The chair was taken by Mr. J. C. Kjellberg.

In proposing the toast of the Institute, Mr. Kjellberg said that many Swedish ironmasters and metallurgists had been members, and three—Akerman, Gjers and Brinell—had been awarded the Bessemer Gold Medal, which it was recognised was one of the great distinctions of the metallurgical world. The fact that Sweden was once more the scene of the autumn meeting of the Institute gave proof that the Swedish industry had something of interest to show. In a comparative sense the works which would be visited were small, but he recalled the fact that at about the time Jernkontoret was founded the number of Swedish works producing wrought iron was about 450, the output being larger than that in any other country, and about twice as large as that of England at the same time. For the further progress of the industry in which they were all interested, it was essential that metallurgists in all countries should co-operate and exchange experiences. The research work necessary to advance the science and practice of metallurgy was far more than one country alone could undertake. It gave them much pleasure to have as one of their guests the grand old man of the Institute, Sir Hugh Bell, who had been a member since its foundation nearly sixty years ago.

Sir Peter Rylands, in acknowledging the toast, said that those engaged in the British branch of the iron and steel industry looked upon Sweden as its nursery, and recognised that she had in various ways set an example to the other countries in which the industry was carried on. In Great Britain it was a rare occurrence for an association of manufacturers to last longer than twenty-five years, but for a period of nearly 200 years the Swedish Ironmasters Association had persisted. It constituted an outstanding example of the advantages to be gained by a policy of co-operation which Great Britain and other countries might take to heart.

At the conclusion of the toast the dinner developed into an informal gathering of a delightful character, and over the coffee and cigars opportunities were given for that frank interchange of opinion which is desirable on such an occasion, but which is not so easy to attain in the atmosphere of the Conference hall. Dancing was also indulged in and formed a pleasant conclusion to a most agreeable entertainment.

Cracking of a Concrete Road.

We have received from Mr. J. B. L. Meek, M.Inst, C.E., City Engineer, Manchester, some interesting particulars concerning the construction of a road called Victoria-avenue, in Manchester, which recently fractured in a curious manner. A photographic view of the fracture is given in Fig. 1, while in Figs. 2 and 3 are given sections through the fracture, and details of the method of road construction.

The road is 80ft. wide between fences, and the width of the carriageway is 50ft. The foundations consist in one part of clay and in another of peat bog, the length of each class of foundation being approximately equal. On the peat bog the road is constructed of reinforced concrete 12in. thick at the centre and 9in. thick at the edges. The lower

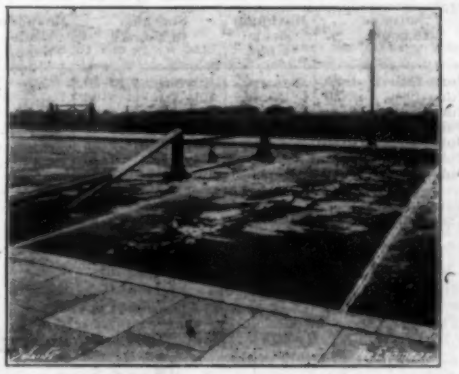


FIG. 1—THE CRACKED ROAD

layer is 7½ to 1 concrete, and the upper layer 3 to 1 concrete, 2in. thick. The reinforcement is double reinforcement, with shear members weighing 25 lb. per super yard, and this is covered with 2in. of concrete at the top and 1½in. at the bottom. The aggregate for the concrete was granite stone and granite sand, and all materials were of excellent quality.

The work was carried out on the alternate bay system, and each bay was constructed in one operation as a homogeneous mass. The length of the bays is 13ft. and the width 55ft., as the carriageway was continued 2ft. 6in. under each kerb. The length of the continuous stretch of concrete is 5150ft., joining on to another concrete road at one end and abutting on a tar macadam road at the other. No special expansion joints were provided, the joints between the alternate bays being considered sufficient to allow for any expansion.

The concreting was commenced on August 11th, 1922, and completed on February 19th, 1923. The average temperature between these dates was 47 deg. Fah., with a maximum of 71 deg. Fah. and a minimum of 26 deg. Fah. At 5 p.m. on July 13th, 1926, the concrete fractured at the centre of a bay 2760ft. from one end of the length of road. The fracture went right through the whole width and depth of the road. The fracture occurred on the peat bog, where the road was on a gradient of 1 in 123.

The concrete on both sides of the fracture was good, the adhesion between the concrete and the reinforcing

bars was also good, and the longitudinal bars at the top and bottom of the reinforcement had buckled upwards but not fractured. The foundation showed no sign whatever of disturbance. The bay in which the fracture occurred was constructed on December 11th, 1922, when the minimum temperature was 38 deg. Fah., the adjoining bays being laid on December 19th and 20th, 1922, when the minimum temperature was 38·9 deg. Fah and 33·8 deg. Fah. respectively. The maximum shade temperature on the day the fracture occurred was 87·6 deg. Fah. The surface temperature of the concrete was not taken, but must have been at the least 120 deg. Fah.

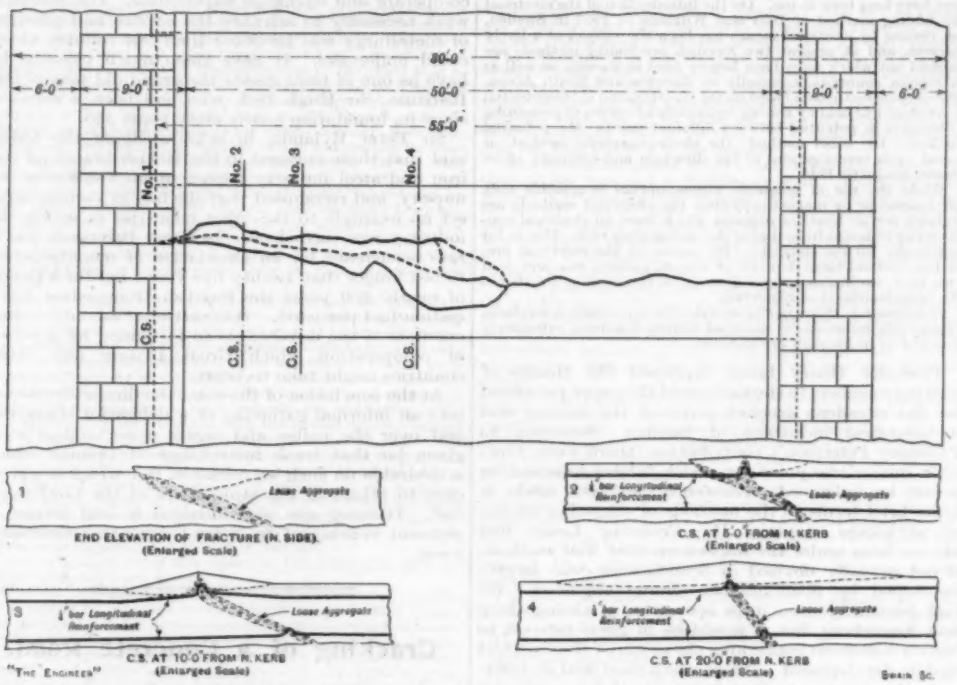


FIG. 2—PLAN OF ROAD AND SECTIONS THROUGH FRACTURE

TABLE I.

Maximum Temperatures and Hours of Sunshine for the Seven Days Preceding the Date of Maximum Temperature Since the Road was Constructed.

	1923.			1924.		
	Sunshine in hours.		Maximum shade temp.	Sunshine in hours.		Maximum shade temp.
June 28th	1·80			July 6th	10·50	
June 29th	8·20			July 7th	5·05	
June 30th	3·4			July 8th	4·25	
July 1st	0·05		89·4° F.	July 9th	12·40	86·9° F.
July 2nd	0·55			July 10th	2·75	
July 3rd	—			July 11th	7·10	
July 4th	0·10			July 12th	5·95	
Total hours sunshine	14·15			Total hours sunshine	48·00	

The extraordinary thing is that the road has been subjected to greater temperatures previously and longer hours of sunshine, as the accompanying tables show, without the slightest sign of damage.

TABLE II.

	1925.			1926.		
	Sunshine in hours.		Maximum shade temp.	Sunshine in hours.		Maximum shade temp.
July 16th	4·25			July 7th	1·00	
July 17th	0·45			July 8th	3·35	
July 18th	4·70			July 9th	2·60	
July 19th	7·05		90·0° F.	July 10th	2·35	87·6° F.
July 20th	1·10			July 11th	7·25	
July 21st	0·20			July 12th	4·75	
July 22nd	0·25			July 13th	9·65	
Total hours sunshine	18·00			Total hours sunshine	30·95	

From the figures in these tables it would appear that the road should have failed in 1924, having regard to the greater total number of hours of sunshine. It has been suggested that the reason for the failure in 1926 was the fact that the air was so much clearer on account of the coal strike, and that, therefore, the sun's rays had a greater power of penetration than is usually the case near a smoky manufacturing town.

Mr. Meek states that the failure appears to be due entirely to expansion. The expansion for the total length of 5150ft., taking the average temperature during construction as 47 deg. Fah. and the temperature at failure at 120 deg. Fah., is 25in., or $^{1}/_{16}$in. per joint. When the buckled reinforcing bars were straightened out, the horizontal movement recorded this way was 1in.

SIXTY YEARS AGO.

THE mid-Victorian period, as commonly judged by modern eyes, cramped its outlook and restricted its ideals by its adoption of utility and commercial success as the chief aims of man's achievement. It would be wrong to suppose, however, that the illiberal spirit of the times was perceived by no one, that none raised a protesting voice against the grinding debasement of noble motive to satisfy the complacency of successful commerce. The age was striving against the more obvious crudities and barbarities inherited from pre-mechanical times, and some of the less blinded were even beginning to perceive that what had been added to that inheritance was in many respects little to the credit of the generations responsible. In criticising the mid-Victorian era, it would therefore perhaps be as well if we of to-day admitted to ourselves the possibility that our own contributions to progressive welfare will be judged crude and barbarous by a later generation. A leading article in our issue of August 31st, 1866, shows that we at least in all the welter of commercial development that marked the times still preserved an outlook not wholly contaminated by the all-pervading quest to exploit our unrivalled industrial position for the sake, firstly and lastly, of financial gain. Our article bore the unpromising title "The Contract System," but was in reality an exposure of the lowered motives behind all, or nearly all, branches of productive activity. We could not agree with the few who still held that the world would again produce painters like Raphael, sculptors like Michael Angelo, architects like Inigo Jones, and musicians like Handel and Mozart. The absolute genius or mind was no doubt present with us in the seed, but the age did not afford the soil that would bring the seed to perfection. The time was gone when the love of his art was the sole motive required to spur a man to his highest exertion. No longer was an architect told to plan a building to surpass anything of its kind previously attempted; he was instead instructed to prepare plans for one which in cost was not to exceed a given estimate. As with the designing, so it was with the execution of the work. The builders of the early cathedrals and palaces derived no profit from achieving their aim. But now if a contractor chose to do so, and was permitted, he could substitute bad workmanship and material for good and put the money saved in his pocket. The same spirit pervaded engineering. Even operas were composed at so much a piece, books written at so much a volume, pictures painted and walls covered at so much per square foot. It was, we wrote, the age of piecework, a system which encouraged the application of labour but suppressed the development of merit. The industrial changes that have taken place since our article was written have certainly done nothing to make our lives and the motives ruling them less piecework in their nature. The interval has but confirmed the judgment to which we came sixty years ago, that to return to the old system of working unfettered by the contingencies of time and money was impossible.

THE Borough of Middleton, in Lancashire, has only a branch line for its railway communication. Some half-a-dozen miles to the north is the Borough of Heywood. To get from one to the other means not only a change at the junction station, but a detour *vid* Castleton. It is now proposed that the corporations of the two boroughs and of the City of Manchester shall jointly build a light railway between Manchester-Middleton-Heywood. After an inquiry by the Light Railways Branch the Ministry of Transport intimates that the proposal may proceed. The issue of the necessary Order will, however, be subject to the inclusion within it of a condition that no part of the railway shall, except with the Ministry's consent, be laid in any public road, unless arrangements are made securing that at the time of the construction of the railway the carriageway is of such width as to leave on both sides a clearance of at least 9ft. 6in. between the edge of the carriageway and the nearest rail.

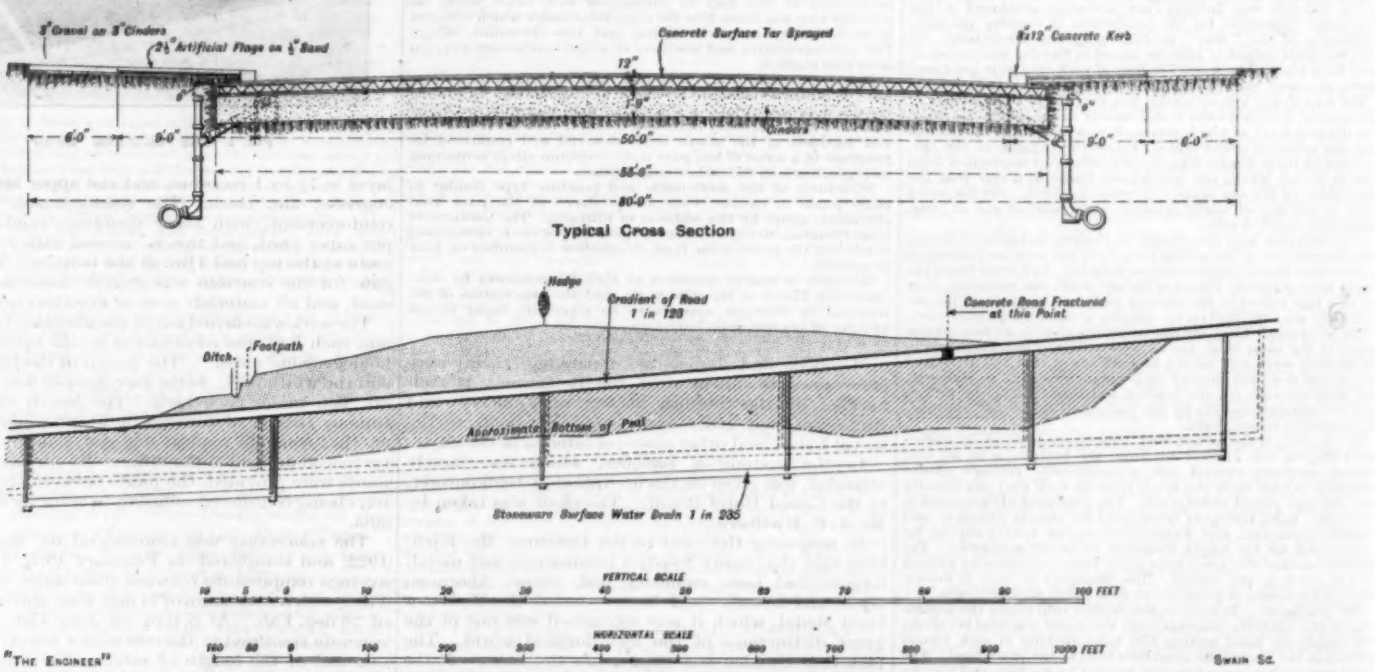


FIG. 3—SECTIONS OF ROAD SHOWING METHOD OF CONSTRUCTION

Railway Matters.

THE London, Midland and Scottish Company is building one hundred 2–6–0 mixed traffic locomotives. Seventy are being constructed at Crewe and the remaining thirty at Horwich. The cylinders—outside—are 21in. by 26in., the diameter of the driving wheels is 5ft. 6in., the weight on the coupled wheels 56 tons 3 cwt., the weight of the engine is 66 tons, and of the tender 42 tons 4 cwt.

ALTHOUGH it was announced some time ago that the summer cheap fares of the railway companies would continue in force until the end of October, the intimation has already been made that the winter train service will come into operation on September 20th. Actually, there has been no summer service, as generally understood, this year; certain extra trains were put on to meet the holiday traffic, but those are now to be withdrawn.

TO-DAY, September 3rd, is the first anniversary of the serious collision at Hope, on the London, Midland and Scottish, whereby three trainmen lost their lives. The subsequent inquiry by Lieut.-Colonel Mount showed that on that—the Midland—section neither the blocking-back rule nor the provision of lever collars was in operation. Either of those would probably have prevented the irregularity that led to the collision, and it is a satisfaction to know that lever collars—a means for reminding a signalman of the presence of a train—have been sanctioned.

A FATAL collision occurred on the Victorian Government Railways, at Caulfield—a station in the Melbourne electrified area—on May 26th, owing to a passenger train running into a stationary train. Three passengers were killed. At the coroner's inquest it was shown that the signalling was correct, and a verdict of manslaughter on the part of the driver and guard was returned. During the last forty-five years only sixty-nine persons have been killed in train accidents in Victoria, of whom forty-four lost their lives in the collision at Sunshine on April 20th, 1908.

TWENTY passengers and one railway servant were killed by the derailment, early in the morning of the 19th ult., between Leiferde and Meinersen, east of Hanover, of the express from Berlin to Cologne. Investigations prove fairly conclusively that the rails had been wilfully loosened. To do that must have been rather a long job, as the rails are flat-bottomed and held by coach screws fastened to the sleeper; it meant something more than removing the fish-plates and fish-plate bolts and knocking out the keys, as was done in the wilful derailment at Cramlington, near Newcastle, on May 10th during the general strike.

THE four quarterly returns of railway accident reports for 1925, now being complete, it is seen that the more serious accidents to railway servants inquired into numbered 161, of which 49 were fatal cases. The reports on the latter show that want of care on the part of the deceased led to 23 deaths, whilst one was due to want of care by a fellow servant. In fifteen instances the cause was an accident or misadventure; in six there was no look-out man, whilst in one the look-out was insufficient; in one a signal post was foul of the line; in one no coupling pole was provided; and in one the cause was unknown.

ON a section, some miles in length, south of Darlington on the North-Eastern area of the London and North-Eastern Railway, automatic three-aspect day colour-light signals are to be erected. The installation is of interest, first, because it provides the first purely automatic signals in this country since the installation, in April, 1923, between Marylebone and Wembley on the same railway, and, secondly, because the signals will be lighted electrically by "approach lighting," *i.e.*, the lights normally will be out but the approach of a train will illuminate them and its passage will switch the lights out.

THE London County Council is widening Old-street and Kingsland-road, adjoining the Shoreditch Station of the North London section of the London, Midland and Scottish Railway. The thoroughfares are being widened from 42ft. 6in. and 45ft. respectively to 60ft. The railway, which has four roads, is carried by bridge over both roads, and the street alterations necessitate the reconstruction of the west abutment of the bridge over the Kingsland-rd. and of the north abutment of that over Old-street. New steel superstructures will be required for both bridges. The main portion of Shoreditch Station will also need reconstruction.

ANY stick would appear to be good enough to beat the railway companies with. Thus, in *The Times* of the 25th ultimo, was a complaint that there was no lavatory accommodation on the 7.33 a.m. workmen's train from Weybridge to Waterloo two days previously. The writer said: "It is this kind of thing that annoys us workmen and causes class hatred." That remark, we suppose, means that the workmen are denied such conveniences. Granted that that be so, it must be remembered that workmen travel at a very reduced rate. The Railway Returns for 1925 show that the average receipt per mile of a third-class passenger was 1·294d. and of a workman 0·528d.

LAST Easter Monday, April 5th, was very sunny at noonday and particularly hot for the time of the year. A sequel to those conditions was the derailment of a passenger train on the single line between Tanfield and Masham in the North-Eastern area of the London and North-Eastern Railway. There was no question of excessive speed or of the suitability of the engine or rolling-stock, but, as regards the permanent way, the ballast was seriously deficient at the curve where the derailment occurred, particularly under the higher rail—which had a super-elevation of 3¾in.—where the sleepers were resting on the top of the ashes. The road was, further, at least ¼in. and, in places, ½in. tight to gauge. The track was second-hand when laid last summer, and the industrial situation had created a shortage of cinders, and that accounted for the deficiency in the ballast. The tightness of the gauge was due to its being reduced to allow for an abrasion on one rail, formed during its previous use. The permanent way staff had been so engaged in getting the section into good order that the men had not had time to loosen the fish-plates. That combination of circumstances and the abnormal heat evidently caused the line to buckle as the train approached. There were no personal injuries. In reporting on the accident, Lieutenant-Colonel Mount says that the greasing of the fish-plates and bolts was promptly carried out after the accident.

Notes and Memoranda.

SOME bronze runners are being fitted in the turbines at the Queenston plant of the Ontario Hydro-Electric Commission, and it is hoped that they will eliminate the troubles which have been experienced with steel runners through erosion.

IT appears, from an article by Drs. Haldane and Henderson, in *Nature*, that an Egyptian native in raising water by means of a shadouf, develops about 4290 foot-pounds per minute. The men work in spells of one hour on and one hour off, for a total of six working hours per day.

ACCORDING to Mr. S. Storrs, of the American Electric Railway Association, "the attempt to substitute omnibuses for trolley service has been tested in a number of American cities of more than 50,000 population. All have returned to the electric car. Among these cities are Des Moines, Akron, Bridgeport and Saginaw. The fact that no city in the world of more than 50,000 population is being served exclusively by omnibuses proves the need for the street car."

RECENTLY published statistics show that the output per hewer per shift in the coal mines of the Ruhr rose from 1·845 tons in 1913 to 2·383 tons in May, 1926, and as applied to the whole body of miners, the average shift performance has advanced from 0·943 ton to 1·1 ton in the same period. This affords some explanation of the fact that the pre-war production has almost been reached with a total number of miners employed that is less by about 6000 men.

A SHORT article in *Power* gives an account of the career of Andrew Kidd, a Scotsman, who for fifty-nine years has been engine-driver at the Burden Ironworks, Troy, N.J. Among his charges there are a 150 horse-power engine which has worked day and night since 1862, a rolling mill engine of the same age, and several engines which were installed in 1882. In the case of the mill engine the only important repairs have been the replacement of the piston and the reboring of the cylinder twice.

IN the preparation of asphalt roofing material at its Kansas City plant the American Asphalt Roof Corporation has found it advantageous to apply electric heating units to maintain an even temperature and consistency of the compound used in the impregnation of roofing paper or felt. Asphalt is pumped into a tank at about 500 deg. Fah. and by the application of electric heat the radiation losses and heat absorbed by the paper are made up and a constant temperature is maintained throughout the whole volume of the saturant.

IN the operation of air compressors it usually happens that oil, carbon and other foreign matters are deposited in the air discharge lines and air receiver. A practical method of cleaning these has been developed by the Compressed Air Society. If a mixture of one pound of ordinary lye and 18 lb. of water is passed into the discharge line at the rate of 60 or 70 drops per minute while the compressor is running, this will clean out all the accumulation on the surface of the pipe and in the receiver, and if the blow-off valve on the receiver is opened, all this foreign matter will be discharged therefrom. This cleaning solution should be used every month or oftener, depending on how much accumulation there may be in the receiver.

A DEPARTMENT of Overseas Trade report on the commercial situation of the country states that the year 1925 saw a great advance in wireless in Hungary, and early in 1925 the new broadcasting station at Csepel Island was put into operation on a wave-length of 546 m. with a power of 2 kilowatts. Programmes were not transmitted regularly until towards the end of the year. There is also working in Budapest a station under the auspices of the Hungarian Telegraph Bureau—*Magyar Tavirat Irada*—which has no set time for transmission. It works on a wave-length of approximately 900 m. and exists primarily to supply its branches—at which places receivers have been established—in Szeged, Szombathely, Győr, Pecs, and Debreczen, with news and other information.

THE permeability of representative natural stones to water has recently been examined by the United States Bureau of Standards. Slate and granite were found to be the least permeable, while limestone and sandstone were the most permeable. Marble appears to come after granite. Permeability of the stone must be considered with other properties before it is adopted as a building material. For instance, the present investigation was undertaken to determine the suitability of various stones for use in building a high dam. Apparatus was designed and constructed by the bureau by means of which the sample of stone could be subjected to any water pressure desired, up to 300 lb. per square inch. This pressure corresponds to a head of 700ft., which was the height of the dam in question.

A NEW apparatus for detecting flaws, lack of homogeneity and other defects not visible on the surface of steel rails is described by Mr. M. Suzuki, research engineer, Japanese Government Railways, in a paper in the *Bulletin* of the International Railway Congress Association, which is summarised in the *Iron and Coal Trades Review*. Tests have been carried out with the instrument on tracks in Japan with satisfactory results. It consists essentially of a coil made in a form to embrace the head of a flat-bottomed rail, the ends being connected with recording instruments. A magnetic flux is produced by a horseshoe electro-magnet with its poles close to the rail, the portion of the rail between the poles completing the magnetic circuit. The coil is placed between the poles, and the whole arrangement can be traversed along the rail on rollers. The results are given in the auto-records of the galvanometer, and photographs of cross-sections at defects prove the efficiency of the instrument as a detector. Three internal defects can be detected:—(1) Cracks and cavities or blow-holes; (2) segregation of impurities; (3) abnormal internal stresses, chiefly due to straightening. The merits claimed for the instrument are simplicity, distinctness and accuracy in detecting faults, portability, and rapidity in operation. The usual time required for testing a rail is between one and two minutes; where rails can easily be handled or have been already laid in the track, as many as 100 can be tested in an hour.

Miscellanea.

THE Tongland Engineering Works, near Kirkcudbright, have been sold, and are to be altered for the production of artificial silk.

SOME tin deposits have been discovered on King Island, in Bass Straits. They are said to contain from 1 lb. to 2 lb. of metal per cubic yard.

IT has been decided that the soda recovery plant at Lake Magadi, East Africa, should be restarted immediately, and orders to that effect have been telegraphed out.

AN increase from 240,000 to 440,000 candle-power has been effected at Lowestoft High Lighthouse. The beam of the present light extends to distances varying, according to the weather, from 20 to 30 miles seaward.

ACCORDING to the *Tribuna* of Prague, it is proposed to establish a magneto works near Olomouc. The magnetos used in Czecho-Slovakia hitherto have been almost exclusively of Italian, German and British origin.

IN accordance with the advice of the Electricity Commissioners, it has been decided to equip the new Govan power house with 50-cycle machinery, with frequency changers, instead of 25-cycle plant, as originally intended.

THE management of the Tilmanstone Colliery is seeking permission from the Eastry Rural District Council to transport coal by an aerial ropeway from Tilmanstone Colliery to Dover, a distance of about seven miles.

AFTER nearly half a century the Foord Pit at Stellarton, Nova Scotia, where forty-nine colliers were entombed after an explosion in 1880, has given up its dead as a result of the old workings having been penetrated.

ALTHOUGH the Fletton brickyards, south of Peterborough, are making nearly 16,000,000 bricks a week the demand exceeds the supply. The supply of Fletton clay for brickmaking, at the present rate of consumption, is sufficient for another 100 years.

THE anticipated capital expenditure for plant and equipment improvements to be made in connection with the Maritime Electric Company's systems in Fredericton, New Brunswick, Charlottetown, Bridgetown, St. Stephen, and the State of Maine, is approximately 150,000 dollars.

THE Communications Budget passed the Egyptian Parliament without amendment on August 30th. It includes an appropriation of £E52,000 for a subterranean telephone cable between Cairo and Alexandria, the total cost of which, £E250,000, is to be spread over several years.

THE erection of works for the manufacture of cement is proposed on an area of land near Port Fairy—Victoria—by a company already in the industry. This company intends to extend its operations, and its general manager will leave for London to consult with British capitalists on this question.

IT is announced that the Toronto Terminals Company has purchased the Polson Ironworks property in Toronto for 318,000 dollars, of which 44,633 dollars is for arrears of taxes. Part of the property is to be used as a viaduct right-of-way and the balance will be used to further the comprehensive harbour development scheme.

IT is officially announced that arrangements are being made for the Spalding Sugarbeet Factory to begin operations as near October 1st as possible. Although completed in the early part of the year, the factory was not able to deal with any of the beet of last season owing to water difficulties. It is hoped that these have been overcome.

A STATEMENT made by the Marine Department at Ottawa shows that the new north channel of the St. Lawrence, below Quebec, will be opened for navigation on June 1st next year, and will continue open during the high water season. This will provide a clear safe route from Montreal to the ocean, whereas the present channel, on the south side, is in the vicinity of the Crane Island flats, and requires caution in navigation.

IN its monthly report the National Federation of Iron and Steel Manufacturers says:—"A natural consequence of the coal stoppage has been the almost complete cessation of production of pig iron and steel. Of the 147 furnaces in blast on the eve of the stoppage, only 23 were in operation at the end of May, 11 at the end of June, and 8 at the end of July. Production of pig iron has therefore fallen from 539,100 tons in April to 17,900 tons in July, and compares with 492,700 tons in July, 1925. Production of steel ingots and castings in July amounted to 32,100 tons, compared with 34,500 tons in June, 45,700 tons in May, 661,000 tons in April, and 590,400 tons in July, 1925."

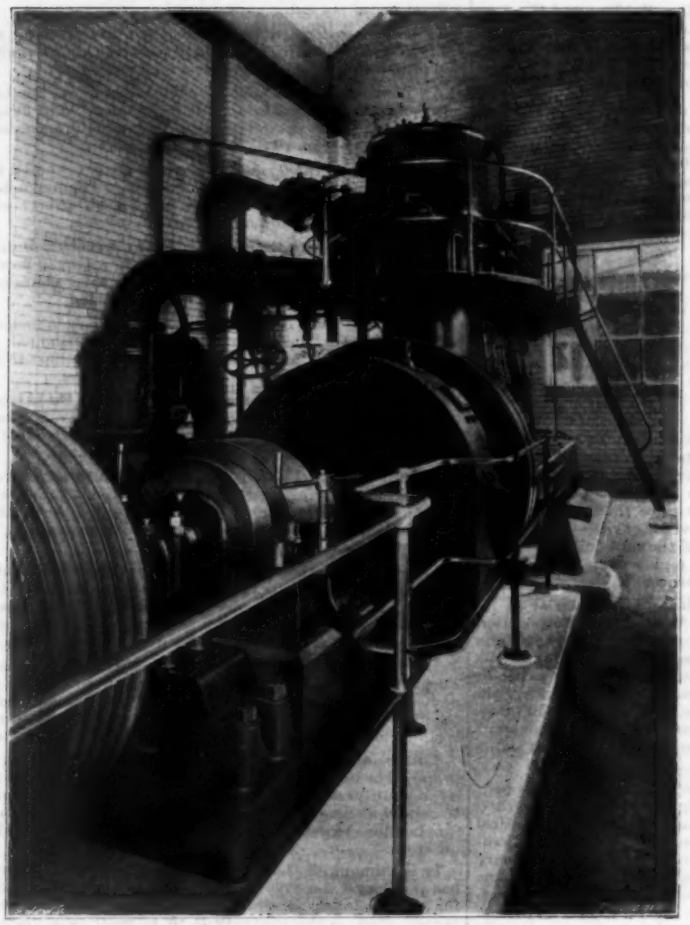
ALL the machinery from the St. Kilda-road, Melbourne, Cable Tram Power House, which was taken out of service when the St. Kilda-road cable trams ceased running, has been sold. The complete equipment of the power house, which cost more than £10,000 to install, has, according to the *Industrial Australian*, realised about £450. The machinery sold included two large steam engines each developing more than 500 horse-power, and five multi-tube boilers, in addition to the ordinary tramway hauling machinery. Most of the machinery has been sold to salvage companies for breaking up. As the use of electric current as a source of power is rapidly supplanting steam-driven machinery, the demand for such engines as those used on the cable tram system is not very great.

ACCORDING to the *South African Engineer*, an important amount of raw rubber will soon be produced from native sources in South Africa. The first unit of the new industry will be in the Eastern Province, probably at Kingwilliamstown. The source of the latex is to be the euphorbia trees which are such a prominent feature of the river banks and kloofs of a belt of country running from Graaff-Reinet through the Transkei to Natal. Of these trees there are literally millions, and their latex contains from 15 to 30 per cent. of rubber, together with about twice as much of resins. The rubber is said to vulcanise well and to be applicable to low and medium-grade goods. The resins also are valuable, particularly for varnishes. Methods of extraction have been worked out successfully, and there is every reason to expect the establishment of a real rubber industry upon sound business lines.

A TRIPLE-EXPANSION PASS-OUT STEAM ENGINE

BELLISS AND MORCOM, LTD., BIRMINGHAM, ENGINEERS

(*For description see page 257*)



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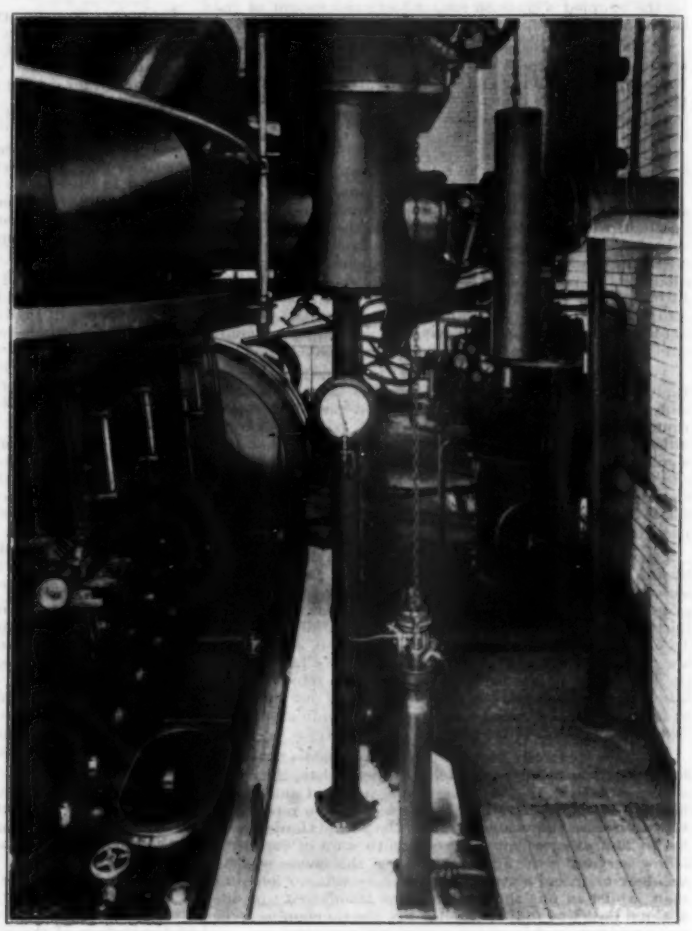
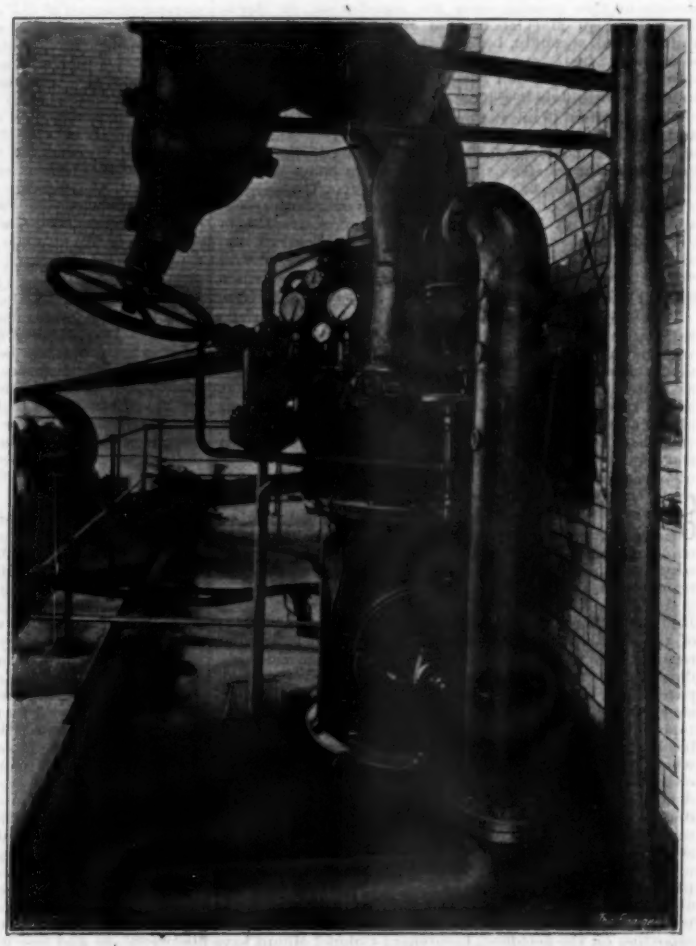


VIEW SHOWING ARCA REGULATOR

VIEW SHOWING CONDENSER



THE CONDENSER

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THE ENGINEER.

SEPTEMBER 3, 1926.

Some French Engineering Problems.

THE dislocation of the economic conditions of Europe has raised problems of particular interest to engineers. At a time when the supply of products was in excess of the demand and every country was able to import what it did not itself produce, there was no incentive to a State to procure at home and in its Colonies what it could obtain cheaply enough from abroad. Grain could be purchased from Argentina, coal could be imported from Great Britain, and oils were obtainable from the United States and Russia. Those importations were indeed necessary for the development of a profitable export trade. The exchanges were normal and advantageous to all concerned. Those conditions of commercial and industrial prosperity have been upset by the aftermath of the Great War. Some European countries can no longer afford to purchase essential products abroad at values which, to them, are increased eightfold. Others can only maintain a relative monetary stability by producing all they can for their own consumption, and everywhere in Europe an economic necessity has compelled countries to make the most of their own resources. They cannot purchase grain, cotton, wool, and oil at extravagant prices. They believe that if they can render themselves independent of foreign supplies it will matter little to them at what level the national currency may stand, since the value at home will be sufficiently stable for all purposes. This ideal is one which all countries with depreciated currencies are striving after. It is, however, an ideal that can never be attained, because few countries can have any pretence to being self-supporting, and even if they could dispense with foreign aid industry would stagnate through lack of markets in which to sell manufactured goods. So long as continental countries endeavour to suppress purchases abroad the conditions of foreign trade will obviously be difficult; but, on the other hand, the efforts being made to develop home and colonial resources are bringing before engineers many interesting problems. Even the intensive productivity of the soil can only be effected with the aid of engineering skill, and vast schemes of irrigation and drainage are to be carried out in the interests of agriculture. Although not falling within the general scheme of economic reconstruction, the draining of the Zuydersee will, at no distant date, increase enormously the resources of Holland, and the enterprise of Dutch engineers, marvellous though it may seem in its magnitude and results, is likely to be overshadowed by works to be undertaken elsewhere. One of the greatest problems, for example, now confronting French engineers is the transformation of Africa from the Mediterranean to the Equator whereby it is expected that vast territories will be supplying France with all the raw material she requires. British engineers have already shown by their magnificent work in the Sudan what can be done, and the results achieved there have impelled the French to prepare equally ambitious schemes in Africa, which they believe are destined to render them eventually independent of foreign supplies of cotton and other raw material.

On the principle that her African possessions from the Mediterranean to the Equator are a natural continuation of France, the efforts of French economists are now centred upon developing the resources of Africa and bringing them within immediate reach of the mother country. These efforts are mainly directed towards the execution of hydraulic works. Hydraulic engineering, in fact, dominates all industrial and agricultural progress and constitutes the basis of all the great schemes that are being carried out. By its means it is hoped to provide the country, with ample supplies of cheap motive power and low water freights, and the canalised Rhone will, in addition, irrigate and render fertile large areas of land that are at present unproductive. In Africa hydraulic engineering has a still wider sphere, for the whole future of that part of the continent depends upon the distribution of the available water supply. Apart from the Sahara there is generally an abundance of water, and even in the desert there are means of procuring water in regions bordering the sandy wastes. Little can be done with artesian wells, which produce brackish supplies, but the heavy night dews resulting from extremes of temperature may be collected for cultivation on the principle of dry farming. Anything which can be done to economise the very small quantity of water to be found in the Sahara is of primary importance for the development of territories in equatorial Africa. Even in Algeria a large amount of money is spent every year upon the construction and maintenance of dams, irrigation canals and reservoirs, and a sum of thirty million francs has been set apart for such works in the current year. These undertakings, while contributing so largely to the prosperity of the North African department, are of but small importance compared with the vast projects which have already been begun for creating a cotton-producing centre on each side of the Niger between Bamaku and Sansandig, where it runs parallel with the Bani. It is believed that the territory watered by those rivers will in time rival Egypt as a producer of cotton. The barrages will not be of such huge dimensions as those on the Nile, but there will be more of them, and the irrigation system will be far more extensive. A small dam already constructed has rendered possible the supply of electrical energy for local uses as well as for the electrification of the railway which is being extended from Saint-Louis. Taken altogether, the Niger hydraulic scheme, when carried out, will rank amongst the most important of its kind. For the moment, however, it is little more than a project, for the expense involved is enormous and there is much to be done before it can be carried into effect. Still it is a highly interesting engineering problem which will be realised in time. Meanwhile a little is being done with local resources; irrigation work is making progress, and a considerable amount of experimental work in cotton growing is being carried out. As knowledge of the interior of the continent increases new hydraulic problems arise, a particularly interesting one being the discovery that Lake Chad is in danger of drying up through a threatened diversion of the water supply to the Niger Valley. This it is proposed to remedy by the construction of a dam. Again, climatic conditions are found to change with the destruction of forests through the heavy demand for colonial timber. This is particularly the case on the confines of the Sahara, which is extending irresistibly where forests are thinning out. The timber industry, therefore, necessitates a systematic programme of afforestation. The Sahara, indeed, offers a particularly useful field for engineering development.

Then again, it is regarded as essential that the vast French dominions in Africa should be rendered homogeneous by an adequate system of railways and especially by direct means of transport between the Niger and Algeria. Transport of produce and raw material by railways to the Atlantic ports may be satisfactory under normal conditions, but the French desire to avoid the risk of depending upon water-borne supplies of necessaries in time of hostilities, or at least to diminish the risks by

limiting the waterway to a carefully guarded route across the Mediterranean. This will certainly be done in time with the products of the Niger Valley. So far as equatorial Africa is concerned, although it forms a continuation of the other French territories, the distances are so great that the chances of an overland commercial route being opened up appear problematical, but it may fit in with a final scheme of continental traffic when the Niger Valley is placed in direct communication with the mother country. The French have a great belief in the value of equatorial Africa, which appears to be fully as rich in natural resources as the adjoining Belgian Congo. Iron ore is said to exist in abundance, copper is being mined in increasing quantities, the known supplies of graphite are declared to be so great that they will enable the French to control the world's market for that product. There are manganese and coal and even oil, but the extent and value of the deposits can only be determined by further exhaustive prospecting. The bringing of that raw material to France at sufficiently low cost is an engineering problem of the first importance. If the cost is too high the wealth existing in that remote territory is utterly lost to France. So far as equatorial Africa is concerned, future development is mainly a question of labour and of roads and railways to the Atlantic ports, but the Niger Valley requires access through the Sahara desert. Little is now heard of the schemes to construct railways across the Sahara, especially since the successful use of motor cars pointed to the possibility of opening up routes with vehicles of the endless track or six-wheel types. In the coming autumn three missions will leave Algiers, Oran and Constantine, each composed of a dozen persons, including an engineer, members of commercial and agricultural groups and financial representatives. They will cross the Sahara by different routes and will meet at Burrem on the Niger. The object of the missions is to explore the old caravan routes in order to see whether it will be possible to revive the considerable traffic that was at one time carried on across the desert. With motor cars specially adapted for the purpose it is hoped that regular routes will be established so that the products of Central Africa will be brought to Algiers and shipped to Marseilles. In that way alone does France hope to become self-supporting. The same problem exists in some of the British Dominions, and its solution in providing a practical form of transport across the Sahara desert may be expected to have profitable results elsewhere.

The Railway Position

THE recent issue of the Railway Returns for the year 1925 and the fact that it was five years ago—August 19th, 1921—that the Royal Assent was given to the Railways Act, lead us to consider at this moment the effect of that piece of legislation up to the present time. Under the Ministry of Transport Act, 1919, the Government redeemed the promise made on September 5th, 1916, by the then President of the Board of Trade, that the Government control of the railways should continue for two full years after the declaration of peace. That Act guaranteed the companies the equivalent of the net receipts of the year 1913 for a further period of two years and thus control lasted until August 15th, 1921. By a later Act it was provided that the railways were to be combined into four large companies by the end of 1922. That combination was effected by the date named, save for a few details, and the new order of things came into operation on January 1st, 1923, in anticipation of agreements which were subsequently reached. In comparing the railway results of to-day with those that prevailed before grouping we are reminded of what Mr. Lloyd George said in 1908 about our railways. It will be remembered that before joining the Campbell-Bannerman Government in December, 1905, as President of the Board of Trade, he was a very severe critic of British railway methods. A couple of years of office effected a great change in his opinions, and we find him saying in the House of Commons on February 11th, 1908, that "He was more and more convinced since he had had the opportunity of coming into close contact with railway administrations that it was one of the most important problems connected with the trade and commerce of the country. . . . With all the material at their disposal and considering all the difficulties of the case, he believed that our railways were very ably managed in the main. . . . . He thought they had done their best for the general public of the country." In view of the praise frequently bestowed on the administration of American and German railways, it is of some interest to make a further quotation. The late Mr. Wilson-Fox, the member for the Tamworth division, was Chairman of the Select Committee of August-November, 1918, on Transport. Speaking in the House on July 8th, 1919, he said:—"It is common ground among those who have knowledge of railway affairs that the management of English railways, far from being inferior, is superior to that of any other country in the world. English railways have led the world in efficiency of management." We may also recall the high opinions of British railways expressed by the author of a series of articles entitled "Notes on British Railways by a Continental Engineer," which appeared in our issues of February and March, 1926.

British railways entered upon the new era in their existence under a certain disadvantage. In order, possibly, to win support for the very drastic proposals he made when the Act of 1919 was going through Parliament, Sir Eric Geddes first showed how bad was the then financial condition of the railways and then indicated what he expected would be the economies effected by the changes he proposed. Under both those headings he was, quite unintentionally, of course, wide of the mark. In his remarks as to the loss on the working of the railways he kept confusing what actually was a greater cost with a deficit or a loss. For instance, in one place he said that the railways were being worked at a loss of something over £250,000 a day, or £100 millions a year. Actually, that sum was the greater expenditure in 1919 when compared with 1913, and he forgot that from that excess there was to be deducted the concurrent greater receipts, which amounted to 20 millions from general traffic and another 59 millions from Government traffic. Such an unfortunate misrepresentation did not, however, do the companies any harm, as they were controlled by the Government, upon which the responsibility, if they were not on a paying basis, lay. It was altogether different with what Sir Eric said as to the possible savings that would result from his proposals. His words, quoting from the official reports, are:—"The economies which can be effected, even with a certain amount of unity of control, but not complete unity of capital, have been estimated by a very able and experienced independent railway expert and a very able accountant at about 20 millions a year, and it is going to take years even to reach that." Incidentally, that estimate was raised to 25 millions when the Railways Bill was up for second reading in May, 1921. It should further be remarked that the economies were to be won by standardisation, electrification—"with heavy electric locomotives"—and the abolition of the privately owned wagon. With that certain amount of looseness of speech, of which we have given an example, Sir Eric failed to say what year was taken as the basic one upon which the reduction was to be made. It is unfortunate that the railway interests did not challenge the figure. Not a word was said in 1919, whilst in 1921 the only mention was a passing comment by two railway directors in the House of Commons on second reading. It is only since the present proceedings were opened before the Railway Rates Tribunal that it has been stated by the companies that they have no knowledge as to how or by whom the estimate was prepared and that they could not accept its accuracy. All through the period of Government control the relevant figures for comparative and other purposes were those for the year 1913. It was, however, absurd to suggest that even 20 millions could be cut off those figures, seeing that the total expenditure was only 76 millions. That Sir Eric had in mind any of the war years can hardly be believed. The costs then were exceptional and could not be taken as a reasonable standard. We may observe that already the expenditure is over 70 millions less than it was in 1920. Whilst thus we are quite in the dark as to what year's figures are to be reduced by 25 millions, we may take for consideration the last year before grouping was effective, *i.e.*, the year 1922. In that year the expenditure on railways proper was 175 millions, and as last year it was 165 millions, it appears that a saving of 10 millions has already been effected. Sir Eric said that it would take years even to reach his 25 millions, but we see that in the three years which we have selected 10 millions have been saved and without more "standardisation, electrification and the elimination of the privately-owned wagon" than the railway companies had in view. It is possible that some reader may refer to the Railway Returns and there see that the receipts in 1925 were nearly 20 millions less than in 1922 and jump to the wrong conclusion that the saving of 10 millions was a natural result of decreased work. It must therefore be recalled that in 1922 passenger fares were 100 per cent. higher than in 1913, whereas they were only 50 per cent. higher last year, and that freight rates were similarly reduced. Moreover, there were, exclusive of the tube railways in London, 985 million passenger journeys and 316 million tons carried in 1925, as compared with 945 million journeys and 302 million tons in 1922. We see, therefore, that although traffic increased and fares and rates fell, yet the companies effected a considerable reduction in expenditure. Engineers will find satisfaction in the knowledge that 8½ million pounds were saved by the civil and mechanical engineering departments. Traffic expenses were down by one million, but, on the other hand, locomotive running expenses were higher by one million, owing entirely to more wages being paid to enginemen; the cost of fuel was exactly the same.

When the conditions which prevailed during the period 1922–25, which we have taken for review, are remembered the results may be regarded as satisfactory, but there is in them little that we can say is the direct outcome of grouping. Economies have doubtless been effected by the reduction of redundant trains and in other minor ways, but it is far from certain that, given the same general conditions, the total expenditure of the old railway companies would not have shown the same reduction as compared with that of 1922 that has been effected by the four groups. We have already observed that the three directions in which, according to Sir Eric Geddes, economy was to be sought have not been followed. The heavy electric locomotive has made no progress in this country, the problem of the privately owned wagon has not been solved, and standardisation has made little, if any, more progress than it was making under the old conditions. On the whole it would seem that the saving is to be attributed rather to normal progress than to any exceptional cause associated with "grouping," though it would be unfair to say that grouping has not stimulated efforts or that in the long run it will be ineffective.

Industrial Radiology.

By E. W. LEWIS, M.A., Ph.D.

X-RAYS are generated when a high-tension current of electricity is passed through an evacuated tube suitably designed to withstand the heat developed, these rays penetrating opaque substances in inverse proportion to the density of the substance examined. X-rays are of wave lengths varying from about 5×10^{-8} to 5×10^{-10}. The physics of X-rays is one of the most important and outstanding branches of the modern work in the realm of atomic structure. X-ray spectroscopy is yielding astonishing results in the hands of workers in this branch of science all over the world. Two types of X-ray tubes are used; in one type traces of a gas at a very low pressure are left, whilst the second class a high vacuum is used. In industrial radiology, high-vacuum Coolidge tubes, utilising high voltages, are used almost entirely. The voltages used in exciting X-ray tubes may vary from 50,000 to 200,000 volts, depending mainly upon the opacity of the substance to be examined. The cathode rays are generally focussed on to a platinum or tungsten receiver.

During the last thirty years the industrial application of the X-ray tube has made remarkable progress as an instrument of investigation, and industrial radiology is rapidly assuming a position of considerable practical importance. Its application is based upon the diffraction of X-rays and the differential absorption of X-rays by materials of varying densities. X-ray methods provide an accurate means of diagnosis of diseases in medical practice, and find general application in war surgery. From the pathological application of radiology has developed the technical and industrial applications, including the examination of the materials and structures used in the various industries, and particularly in metallurgy and metallography. At the present time the examination of materials by radiographic methods is the most highly developed form of industrial radiology. The testing of materials is becoming of increasing importance, and the internal structural examinations for uniformity of finished castings and products can only be efficiently effected by radiographic methods. They cause no injury to the material or structure examined, and are the only exhaustive methods for detecting flaws, examining concealed joints or the defective building up of the internal parts of a structure. The advancement of radiographic methods in metallurgy is in a high degree due to the introduction of the Coolidge tube, which consists principally of a vacuum tube containing a cathode electrode of platinum or tungsten, and a focussing device consist-

ing of a molybdenum cylinder and a tungsten target. A Coolidge tube costs about £60, and has an active life of about 120 hours. In a lecture before the Faraday Society in 1919, Sir Robert Hadfield stated that "to meet the more severe conditions of modern life, in which the technolgoist is called upon to do what almost seems the impossible, there is no reason why we should not study new means of ensuring perfect materials in our constructions, and it is hoped that radio-metallography is going to lend a hand to enable us to do this."

Dr. Knox gives the following as a list of manufactured substances which are examined industrially by means of X-ray methods :—Cartridges, torpedoes, bullets, fuses, grenades, shells, rubber tires, golf and cricket balls, electrical cables, carbon electrodes, ferro-concrete, engine parts, watches, electrical instruments. They are also used in chocolate manufacture and in boot-fitting operations. Industrial radiology is applied by two principal methods, radiography and crystallography. Its use is based on the production of an outline structure of the object by the casting of the shadow on to a fluorescent screen. To attain successful results numerous precautions are necessary, as objects of a metallic nature require lengthened exposures and the attendant effects of scattered radiation may reach the photographic plate and envelop the main image, vitiating the final results to a considerable extent. However, with modern X-ray spectrographic appliances, most of the difficulties have been overcome, and some remarkable results have ensued in the direct ascertaining of the space lattice structure of crystals and also crystal orientation. X-ray crystal analysis also affords a means of studying ductility and eutectic mixtures in alloys. Radiographic examination of alloys reveals any unequal diffusion of the components of an alloy, by exhibiting vein effects. Steel castings and cable armours are also examined for defects by this method.

Diffraction phenomenon in radiology can be expressed in terms of the wave length of the radiation giving rise to the effect and the dimensions of the spacings forming the diffraction grating. By experimenting with X-rays of known wave length upon crystalline substances, the spacing of the atomic planes of the crystals can be calculated from the diffraction patterns produced. The determining of the interatomic forces existing in crystalline bodies is based on this important application of radiology. Bragg has shown that the diffraction of X-rays in crystals is the reflection of the incident rays by the atomic plane structure of the crystals, and that the spacings can be measured together with the angles between the crystal reflecting planes. The three principal methods for determining the grouping of the atoms and molecules in a crystal are :—

(1) Bragg's method using a spectrometer, in which a homogeneous ray is reflected from a single crystal.

(2) Laue's method, in which heterogeneous rays are passed through a single crystal.

(3) Hull-Scherrer method, in which homogeneous rays are passed through a thin layer of crystalline powder.

An important industrial application of the study of atomic structure of the metals and alloys has shown the characteristic of materials and metals which are of desirable tensile strength and ductility. Owen and Preston at the National Physical Laboratory have shown that in a solid solution of two elements, the replacement of one atom by another is effected by substitution in, and distortion of, the lattice structure, and not by interstitial insertion.

Radio-spectrography is now being applied to the study of iron and the structure of steel, and particularly to the allotrophy of iron at various temperatures ; in this sphere it will probably find considerable industrial application. By this means various metallurgical operations have been studied with considerable detail, particularly the effects and influence of hot and cold rolling, tempering and annealing. By means of X-ray spectrometry, the discovery of new elements has been considerably assisted, recent examples being hafnium, masurium, and rhenium. Amongst the recent chemical applications of X-rays are the study of the naphthalene molecule, constitution of paraffin, allotropic modifications of cobalt and iron at various temperatures, solid solutions, grain size of metals, and the polymorphous modification of salts such as ammonium chloride. X-ray methods have revealed the fact that a large number of substances, previously considered to be devoid of crystalline structure, possess crystalline forms ; amongst these are cellulose, nitro-cotton, soap, rubber, bamboo and leather.

An important practical factor in radiology as applied to metals is the exposure. Kaye—*Conquest*, July, 1921—states that with the modern type of X-ray plates exposures are considerably reduced, with a voltage of 130,000 a radiograph to the depth of 1in. may be obtained in a one-minute exposure. Tool marks and fine mould marks are identified with ease, the opacity being a measure of the quantity of the atoms encountered ; hence the radiograph varies in intensity directly with the density of the metal examined. Practical radio-metallography is based on this principle ; for example, chromium and carbon steels are easily detected owing to their decided varying transparency.

The general value which has been adopted for the comparative absorption of X-rays by different materials is the "half layer value," which is the thickness of material penetrated by the X rays before the radiation is reduced to one-half of its incident value. The "half layer values" of some of the metals is given in the following table—Kempton, "Principles of Radiology," page 15.

Metal.	"Half layer value." mm.
Aluminium	0·28
Iron	0·012
Copper	0·0096
Zinc	0·011
Silver	0·0037
Tin	0·0054
Platinum	0·0015
Gold	0·0014
Mercury	0·0022
Lead	0·0028

The practical and industrial application of radiology to metallography and in the general examination of materials is based primarily on the disparity of penetrability of X-rays through various media. Experiments have also shown that marked differences in opacity appear in steels of carbon content varying from 0·6 to 1·15 per cent., the higher carbon content steel giving a more transparent radiograph. Tungsten steels increase in opacity with increased tungsten content.

X-ray methods have been found to be extremely efficacious in detecting unsatisfactory welding of large castings or defective brazing, no other satisfactory test being available for examining underneath the surface, or for determining whether actual fusion of the separate parts has taken place. Using modern apparatus, pieces of metal 3ft. in length and up to a thickness of 1in. can be examined quickly and with ease, and with exposures of 30 seconds much detail is shown. In this respect the radiograph compares very favourably with a photo-micrograph. Kaye estimates the practical depth to which can be penetrated in various materials is as follows :—

	Inches.
Lead	0·2
Tin	0·48
Iron	3·00
Aluminium	6·00
Wood	15·00

The problem of deep radio-metallurgy is now being developed by means of high-powered hot-cathode Coolidge tubes, and with considerable success in America.

Explosives technology abounds with various technical and industrial applications of radiology, particularly in examining the interior of propellant and initiating charges, liquid grenades, fuses and general ammunition. Irregular distribution of metal in the nose of a bullet or shell, which would cause defective flight, can be easily detected by X-ray methods. The application of radiology in the testing and detecting of defects, such as bad joints, knots, &c., in the wooden sections of aeroplanes are well known, as also its application in rubber manufacture to establish the presence of any foreign matter, or in detecting bias in the core of golf or cricket balls. Electrical apparatus manufacturers use X-ray methods to examine electrodes, built-up insulators, such as micanite, embedded wire installation *in situ*, and magneto distributors. The identifying of soda and lead glass for use in thermometer manufacture is now carried out by means of X-rays, and is a standard test at the National Physical Laboratory, Teddington. Amongst the lesser-known applications of radiology are the identification of "old master" paintings, precious stones, the detection of "tobacco moth" in bulk, the examination of plant life, the examination of reinforced ferro-concrete structures *in situ* and the testing of the fit of a new shoe on the foot.

The postal authorities propose to use radiographic methods for the examination of insulated appliances, such as lead-covered cables, and for detecting foreign bodies in moulded or assembled insulations. Kaye, lecturing at the Leeds University on November 30th, 1925, said that "these are but a few of many examples which indicate that the several processes of X-rays spectroscopy are not only a valuable scientific tool for the physicist, but also that they are destined to play an important *rôle* in many industrial processes of the future. There are grounds for hoping that light may be thrown on the mechanism of such properties as magnetism, electrical and thermal conductivity, contact and thermal electromotive forces, dielectric capacity, fluorescence, the various types of elasticity, cohesion, diffusion and adsorption."

The Nationalisation of French Mines.

THE question of nationalising the coal mines was strongly agitated in France a few years ago, when a Bill was introduced for that purpose into the Chamber of Deputies. Although they are always prepared to discuss social reforms, and put them into operation when it is found desirable to do so, the French are nevertheless very careful to abstain from any legislation which may encroach upon the rights of property. Consequently, during the past six years, the Bill for nationalising the coal mines has been examined in all its bearings, and an exhaustive report, prepared by an expert, was passed on to the Commission des Mines of the Chamber of Deputies, which has carried out a particularly searching investigation. It has taken evidence from the National Miners' Federation, from the Fédération Unitaire, which has communist leanings, from the Comité Central des Houillères and from the Ministry of Public Works. Members of the Commission visited the Saar and the Moselle to investigate the working conditions in the coal districts. As the result of this long and exhaustive inquiry the Commission confirms the conclusion of the report submitted by the expert, and recommends that the Bill for nationalising the mines and creating an Office National d'Exploitation et de Recherches de Mines should be rejected, although it states that it may be desirable to carry out certain modifications to the existing mines legislation.

The first objection raised by the Commission is that, under the law of April 21st, 1810, the ownership of a mine is perpetual, and that the State is only able to transfer that ownership to itself in the public interest by the payment of an indemnity in the form of capital, which means that in calculating the indemnity all kinds of factors have to be taken into account, such as the revenue, the value of the plant and stocks, and even the loss of future profit to the owner. In a word, the owner must not be a loser by any expropriation. It is therefore affirmed that the capital represented by the indemnity would constitute a crushing charge upon a nationalised enterprise. A case in point is the acquisition of the Ouest Railway by the State, which proved to be a particularly onerous financial transaction. Naturally, those who introduced the Bill do not suggest a purchase of the mines. They propose simply to replace existing shares by new stock which will give to shareholders and debenture holders an interest of 5 per cent. guaranteed by the State. The Commission, however, points out that such an operation would be illegal. The only way by which the State could expropriate mine owners would be to buy up all the stock on the open market ; but an operation of this kind would be ruinous to the State, which would have to raise loans at 7 or 8 per cent. in order to buy stock now quoted on the Exchange at figures representing a revenue of 4 per cent.

Continuing its argument, the Commission is of the opinion that even should the State be able to purchase the coal-mining stock with only a small margin between the interest it would pay for the loan and the interest represented by the value of the stock, that margin would still constitute an extra charge for the nationalised mines, which could only be covered by a lowering of wages or by higher coal prices. Even should an operation be possible it is very doubtful whether the State, in the present condition of national finance, could procure the necessary capital, and supposing that difficulty was overcome, the proposed Office National des Houillères would have to borrow every year a sum of 700 million francs, with the State guarantee, in order to increase the annual production by 2,000,000 tons, which is one of the essential conditions of the national organisation. All this would necessarily add to the charges which must be paid either by the miner or by the consumer. Taking the average price of coal at the pit-head, which in 1922 was 75·01 f. per ton, the average amount paid in wages was 34·28 f. The average net profit at all the French collieries was 5 f. per ton, or one-seventh of the cost of labour. One of the avowed objects of the nationalisation scheme is to pay higher wages for fewer working hours, and if wages are increased by only 10 per cent., the whole of the profit disappears, so that the State would either have to work at a loss or raise the price of coal. This latter alternative is out of the question so long as prices are regulated by foreign competition. Therefore, in the opinion of the Commission, no nationalisation scheme is possible unless it becomes international. The Bill will simply drop out without attracting notice, for the public has lost all interest in a scheme which is regarded as impracticable.

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The Electrical Industry in Germany. London : The British Electrical and Allied Manufacturers' Association (Inc.), 36, Kingsway, W.C. 2.

Water Purification Plants and their Operation. Third edition. By M. F. Stein. London : Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 15s. net.

Theorie der Brennkraftmaschinen und deren Brennstoffe vom Standpunkte der chemischen Gleichgewichtslehre. By Ingr. M. Brutzkus. Halle (Saale) : Wilhelm Knapp. Price 3·8 marks.

Income Tax, Super Tax, Excess Profits Duty, &c.: Chart of Rates, Allowances and Abatements for 1926–27. Eleventh edition. By C. H. Tolley. London : Waterlow and Sons, Ltd., London-wall, E.C. 2. Price 3s. net.

Materials of Construction : Their Manufacture and Properties. Third edition. By Professor A. P. Mills. Third edition edited by H. W. Hayward. London : Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 20s. net.

Proceedings, Papers, Remits and Discussions of the Dominion Mining Conference, held at Dunedin, New Zealand, February 3rd to 6th, 1926. Hon. editors, Professor J. Park and Professor D. B. Waters. Dunedin : The *Otago Daily Times and Witness* Newspapers Company, Ltd. 1926.

7500 H.P. WATER TURBINE

J. M. VOITH, HEIDENHEIM, WURTEMBURG, ENGINEERS

(For description see opposite page)

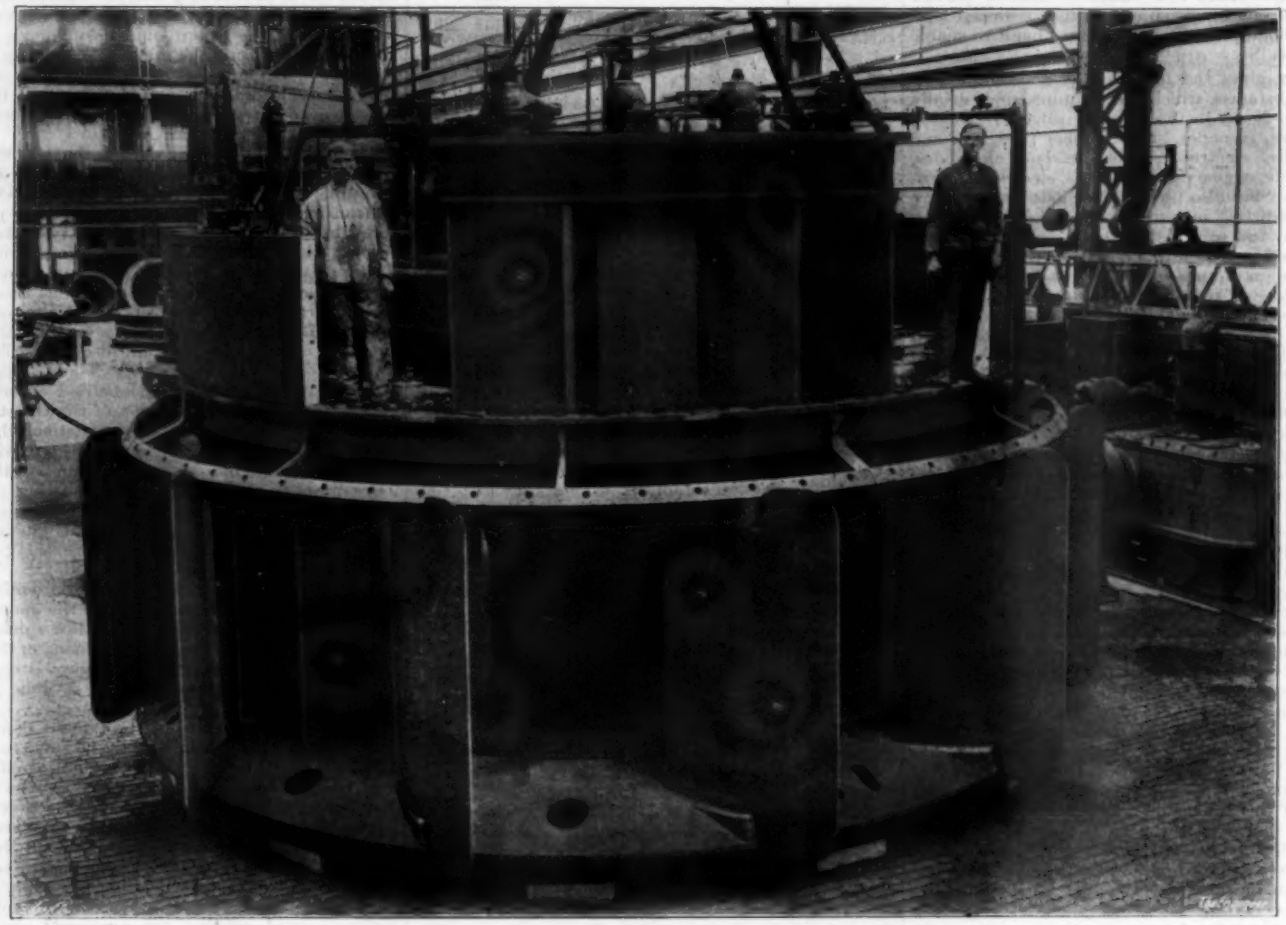


FIG. 1—THE TURBINE INLET CASING WITH ONE GUIDE-VANE SEGMENT RAISED

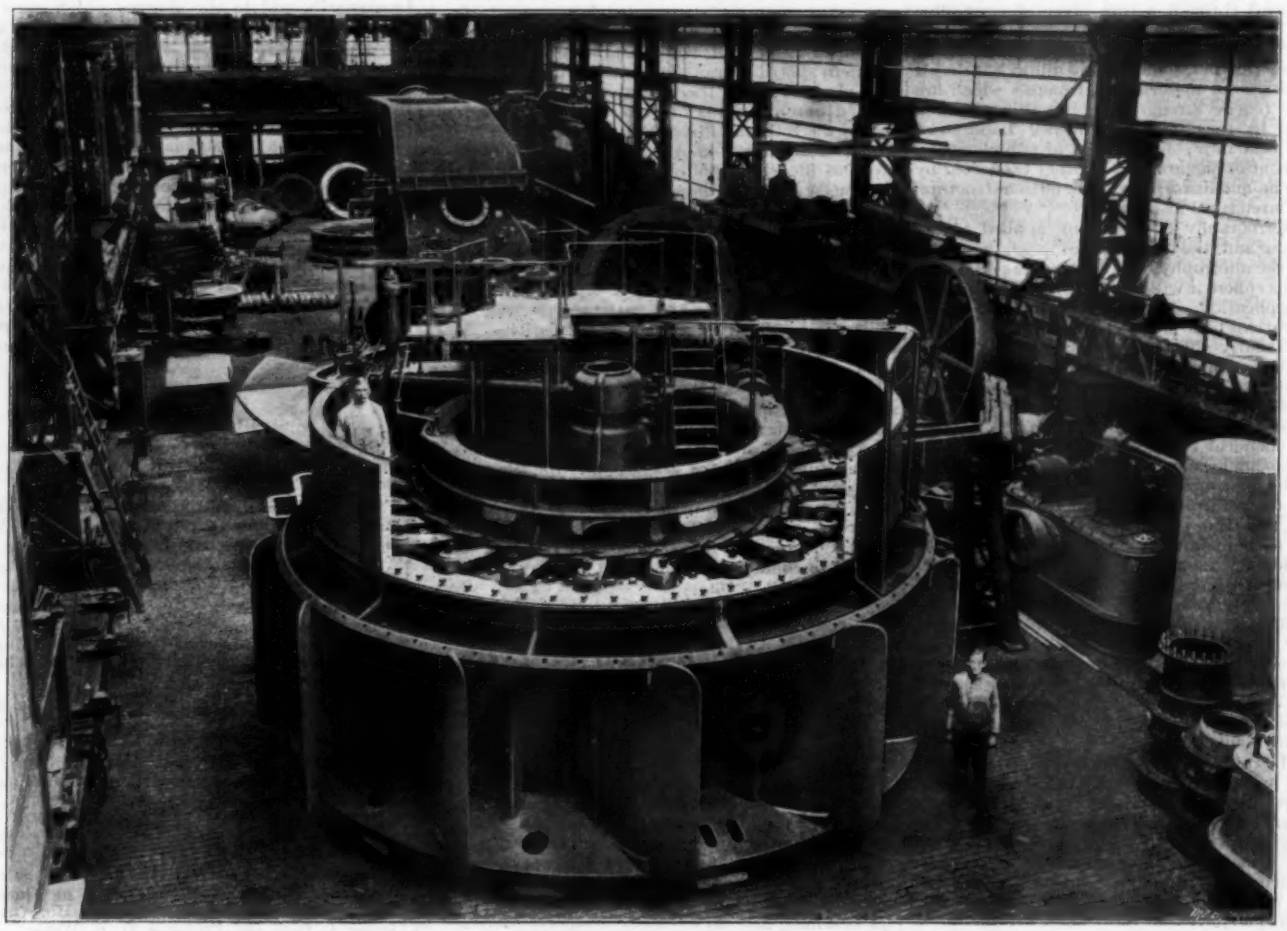


FIG. 2—VIEW OF THE COMPLETE CASING

A 7500 Horse-Power Propeller Type Water Turbine.

ONE of the most impressive of the exhibits of heavy machinery at the Inland Navigation and Water Power Exhibition at Basle, where the Second World Power Conference is now being held, is undoubtedly the turbine runner and inlet casing of one of the six 7500 horse-power propeller type turbines, which are being constructed for the Kachlet Power Plant on the Danube, by J. M. Voith, of Heidenheim, Wurtemburg, Germany. We are indebted to that firm's London agents, Perrin's, Ltd., of Astor House, Aldwych, for some particulars of this large water-power installation.

The Kachlet Dam and Power House is situated on the river Danube, about three miles above the town of Passau. It was constructed by the Rhein-Main-Donau A.G., and it serves the double purpose of regulating the flow of water in the river as well as producing electric power. It was designed to improve navigation facilities at a point in the river which was previously considered to be dangerous to water-borne traffic. The newly built Kachlet Dam raises the level of the river at periods of low water by some 9 m., which insures a minimum depth of 2 m. of water over a river length of about 11 kiloms. or nearly 7 miles.

The completed works will include, in addition to the power house and weir, two parallel locks having two chambers, 230 m. long and 24 m. wide, each large enough to accommodate the usual side-paddle river tugs and a chain of barges. The power house itself occupies a position between the locks and the weir, and it is placed at right angles to the course of the river. It has the following principal dimensions:—Overall length, 148 m.; width, 16·5 m., with a height over the head water level of 21 m. The weir, which runs from the power house to the river bank, has a total length of 175 m., with twenty-five openings, each 6 m. in width.

In Fig. 3 we show a diagrammatic section through the power house and one of the turbine and generator units. When the installation is completed eight such machines will be installed. At present six of the units are ordered and built, and the erection of several of them has already been begun. The last two sets will be ordered at a later date. The turbine, which is of the propeller type, is designed for a total output of 7500 horse-power when working under a normal head of 7·65 m. and with a water consumption of 87·5 cubic metres per second, the speed being 75 revolutions per minute. At certain times the head on the turbines may rise to 9·2 m., and then the output of the turbine will be increased to 9320 horse-power, with a correspondingly larger water consumption of 92·4 cubic metres per second. The generators, which are being constructed partly by Siemens Schuckert Werke and partly by the A.E.G. Company, Berlin, are three-phase alternators and wound for a pressure of 6300 volts. They are designed for an output of 8500 kilovolt-ampères, or 5950 kilowatts, at a 0·7 power factor, and the generators may be run up to a speed of 150 revolutions over a short period. From the accompanying drawing and engravings some details of the turbine design may be gathered. The turbine itself is anchored into the concrete which surrounds the inlet spiral by two massive upper and lower foundation rings, each 7 m. in diameter, to which the inlet casing—shown in Figs. 1 and 2, on page 254—is bolted. Between the upper and lower rings of the inlet casing vertical webs are fixed, which are shaped so as to form vane guides. The turbine guide wheel itself is attached to the lower foundation ring, and forms the inlet to the turbine chamber in which the runner—see Fig. 6—revolves. The inlet passage is designed with an easy radius of curvature, and the turbine chamber is furnished with a removable sheet steel lining, that being the particular part of the water passage at which the material is most subject to attrition. Below the runner the water passes into the upper part of the draught tube, which is also metal lined. It will be observed that the bend in the discharge tube is provided with a concrete dividing wall, in order to secure as uniform a discharge as possible.

Fig. 6 shows the turbine runner and its shaft, and was taken in the makers' works. The runner has a diameter of 4·6 m., or about 15ft., and it weighs over 22 tons complete, with its conical end nut. It is provided with six cast steel fixed blades, each weighing about 2 tons, which are so fixed in to the boss that they can be dismantled and removed downwards into the draught tube without disturbing any other part of the turbine. The runner shaft has a length of over 8 m., and it is carried up through the turbine to meet the generator shaft. It has a diameter of 475 millimetres, or nearly 18¾in., and the flange coupling is nearly double that diameter. Just above the coupling is fitted a bevel gear wheel, which drives the oil pump, which will be referred to later. At the top of the turbine casing is a stuffing box through which the runner shaft passes, and by that means air is prevented from being drawn downwards into the discharge tube.

With regard to the turbine itself, an interesting point in the design is the arrangement of the turbine cover and the twenty-four movable guide blades. This part of the turbine is clearly shown in Figs. 1 and 2, page 254. The turbine cover, which is carried on the upper foundation ring, is made with six removable segments, each of which carries four movable guide vanes. In Fig. 1 one of these segments is shown withdrawn from the inlet casing. In the centre of the top turbine casing is a cover plate, which also acts as a water guide and so fixes the upper limit of flow of water through the turbine. The cover plate is composed of rings fitted together concentrically, so that they can easily be dismantled for internal examination. The guide vanes already referred to are carried in bearings in the turbine cover, and they are coupled to the governor-controlled regulating or speed ring by the gate rigging, which consists of levers and links, and may be observed in Fig. 2. Each vane is 1·67 m. high, and special arrangements are made by fitting a thrust bearing to relieve the thrust due to its weight. The guide vane spindles are drilled through for grease lubrication, which can be controlled from outside the turbine.

For the purpose of turning the guide vanes from the full open to the closed position through the medium of the speed ring, a governor-operating mechanism of considerable capacity is required. The power developed must instantly reach the high figure of 130,000 foot-pounds. It is furnished by two oil-operated servo motors, which are attached to the upper foundation ring and move the speed ring direct—see Fig. 2—as previously described. The main speed-regulating valve is attached to the top of one of the servo motors, and its movement is effected by an auxiliary servo motor, worked by a pilot valve,

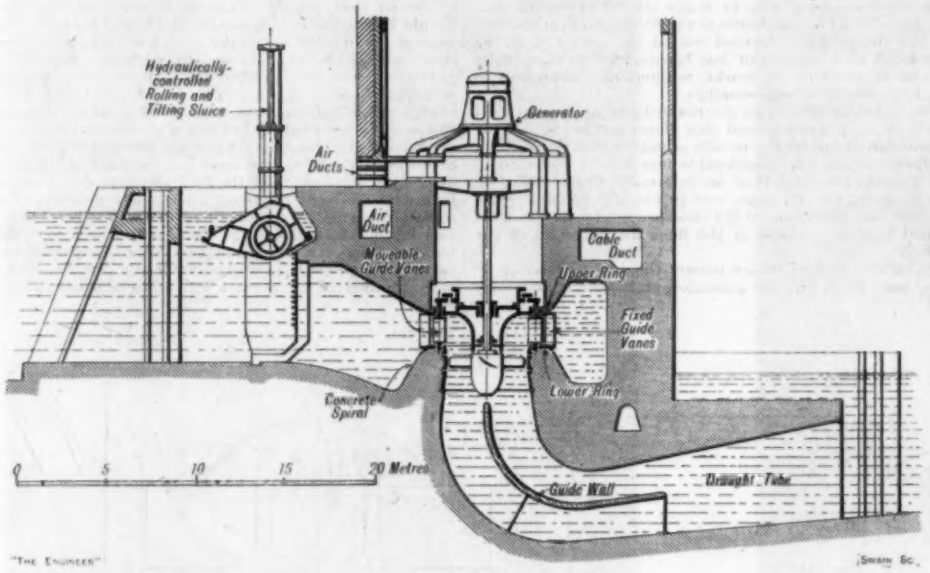


FIG. 3—DIAGRAMMATIC SECTION THROUGH ONE TURBINE UNIT

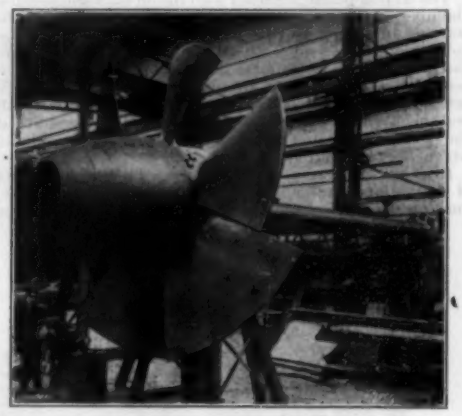


FIG. 6—THE TURBINE RUNNER

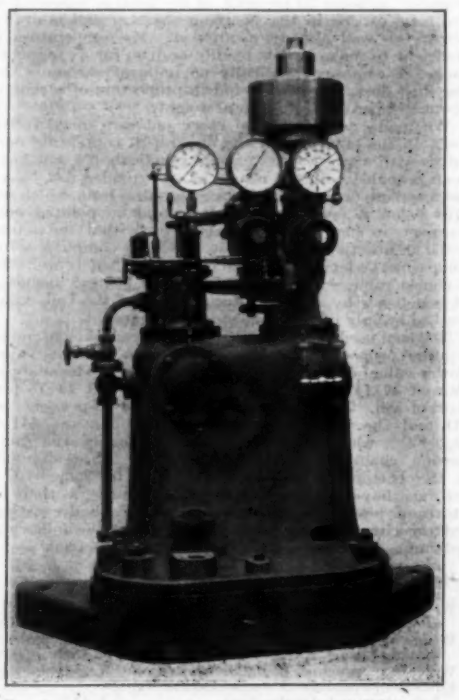


FIG. 4—CONTROL GOVERNOR

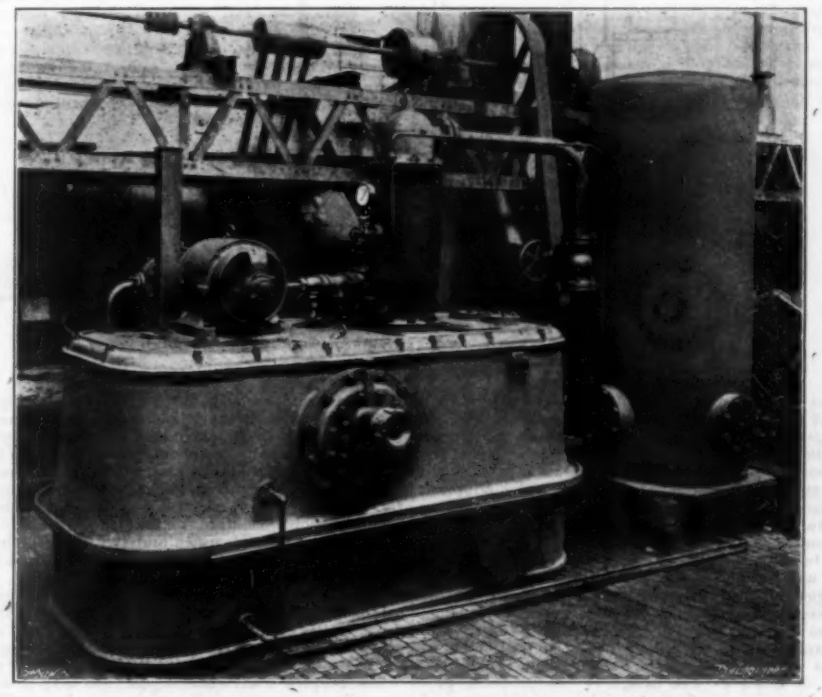


FIG. 5—OIL PUMP AND TANK WITH PRESSURE CHAMBER

which in turn is operated by a small control governor—see Fig. 4—which is fixed on the floor of the turbine house. The control governor takes charge of all load and speed variations, and whilst it is coupled direct to the turbine and is driven by helical gearing, it can also be operated from the main switchboard by means of the two electric motors with which it is fitted.

Instruments are provided on the governor unit showing the pressure of the operating oil, the speed of the turbine, and the degree of guide vane opening.

The oil for working the two servo motors is supplied at a pressure of 15 atmospheres, or about 220 lb. per square inch, by gear type oil pump, which is driven directly from the main turbine shaft through bevel and spur gearing. It is claimed by the builders that the direct driving of the oil pump and control governor by mechanical means obviates possible defects which might be set up in an electrical drive, as a result of short-circuits in the power station, or on the transmission lines.

The oil pump unit, together with the oil tank and pressure chamber, also an auxiliary electrically-driven oil pump for starting up purposes, are shown in Fig. 5. Like the control governor it is placed in the turbine room. For working the main control valve oil is delivered by the pump to an accumulator, whence the supply is taken. With such an arrangement the size of the pump is kept reasonably small, and the oil is only supplied to the governor as it is required, the pump delivering intermittently and by-passing oil which is not required.

Brief reference may finally be made to the lubrication of the turbine and generator. There is only one bearing bush on the vertical turbine shaft which requires lubrication, and it is fed from an oil tank placed on a level with the exciter in the turbine room, which is also coupled to the two generator bearings. Any oil which may work through the bearings is caught in a tray fixed below the turbine bearing and is returned after filtration by a geared pump to the raised lubricating oil tank. By adopting this arrangement both the turbine and generator bearing are maintained in lubricated condition under precisely similar conditions.

It will be seen that in actual service the turbine and generator will be equipped with suitably designed ladders and galleries, so that all parts of the machinery will be readily accessible for inspection and supervision while the turbine is in operation.

The installation we have described is of particular interest as it represents the largest plant of its type in the Continent of Europe. The design of the propeller presented a new problem. As no precedent existed in regard to the design of so large a propeller, a small runner of 250 mm. in diameter was first made and tested, and from the data thus obtained a second model 700 mm. in diameter was built and tried. The results which were obtained from these two model runners provided figures which served as design data for the 4·6 m. propeller that was used in the actual turbine. The results obtained in practice have, we are informed, proved very satisfactory. It is anticipated that the success of this plant will be reflected in future water-power development schemes, especially those in which low heads have to be utilised, and in cases such as those often met with in European power schemes where the supply of water is subject to wide seasonal variations.

Burning Gasified Coal.

THE difficulties associated with the combustion of pulverised coal, such as the wasting away of refractories, the large combustion chambers necessary, and the offensive dust discharged up the chimney, are common knowledge to engineers connected with power supply, and we have on several occasions given descriptions of apparatus devised with the idea of mitigating these troubles. Among these devices one of the most promising which we have investigated is that of Gasified Fuel, Ltd., with offices at 22, Bloomsbury-street, London, W.C. 1, which is really still in the experimental stage, but has been so far developed that we have been able to study its behaviour in connection with a Paxman boiler at the Colchester firm's works. It may be properly pointed out at the outset that the powdered coal equipment has been added to this boiler just as it stood in the works, without any alteration to the boiler-house or surroundings.

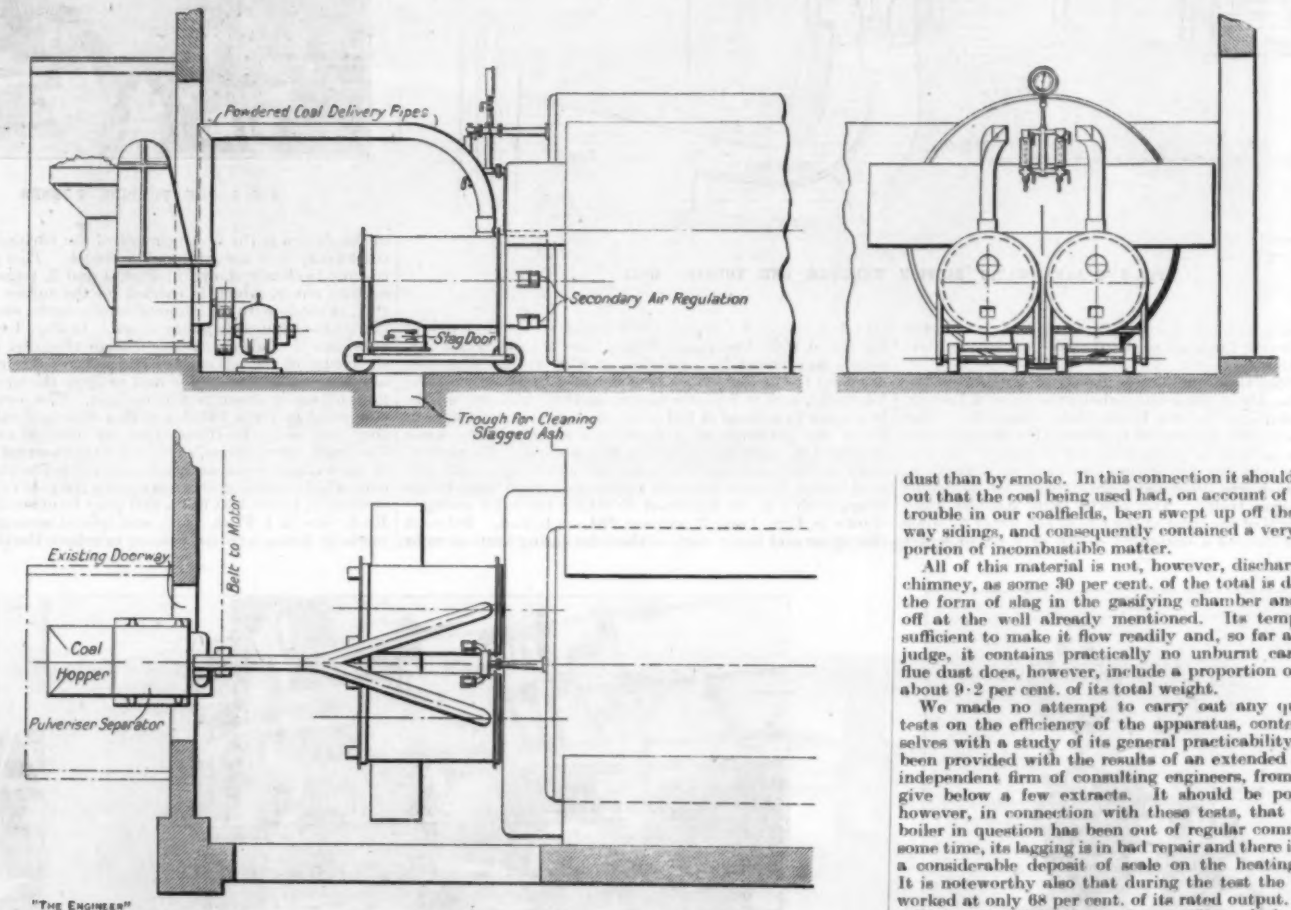
In contradistinction to the majority of apparatus used for burning powdered coal this characteristic is a great advance, as it has been generally admitted that that system of firing requires a considerable increase in boiler room accommodation, and that an internally fired boiler, as, for instance, the Paxman, was practically prohibitive to the scheme, on account of the close proximity of the water-cooled heating surfaces of the flues to the origin of the flame.

With the system under review the boiler is certainly externally fired, but the extension of the plant necessary therefor is no more than is required by a fireman in swinging his shovel and the whole of the apparatus is above floor level. These characteristics are provided by gasifying the coal by means of incomplete combustion and then introducing the resultant gas, with the air necessary for complete combustion, at the mouth of the furnace. In this way the temperature in the gasifying chamber is kept within reasonable limits, so that the refractory lining is not subject to severe usage and the flame in the furnace proper is so well distributed that trouble from the same cause is not experienced there.

The actual apparatus employed is very simple and its arrangement is illustrated in the accompanying line drawing. It comprises a cylindrical brick-lined extension of each of the furnaces, together with the plant for pulverising the coal. The pulveriser, in the case under review, is of the Forplex continental design, but with it we are not specially concerned at the moment. It is sufficient to state that the coal is supplied to the furnace in the form of an impalpable powder.

The boiler in question is 8ft. in diameter by 14ft. 6in. long and has two furnace tubes 2ft. 8in. in diameter with several Galloway tubes. The return tubes are 3in. in diameter and the total heating surface is 1200 square feet. In front of each of the furnace tubes there is a gasifying chamber of approximately the same internal diameter as that of the tube and some 4ft. long. These chambers are mounted on wheels, so that they can be withdrawn from the boiler if necessary. The chambers are lined with fire-brick—quite plain in the case of the plant we have inspected—but it is intended that future sets should have hollow bricks, so that the gasifier may be air cooled and the resultant hot air used in the combustion chamber. The pulverised coal, together with sufficient air for carrying it through the trunking, is delivered into the boiler end of the chamber and a set of fire-brick baffles so directs it that it first goes to the back of the chamber and then is discharged at the front into the boiler furnaces. The furnaces are, by the way, lined all round for a distance of about 5ft. with fire-brick plastered over with carborundum cement. Towards the back of the gasifying chamber there is a well at the bottom, in which slag may collect and be drawn off, either periodically or continuously, through a notch, as may be desired. At the end of the gasifier near the boiler there are three openings which admit the air required for the complete combustion of the fuel. Apart from the simple apparatus just described the arrangement of the boiler is normal.

In view of the difficulties which are experienced in getting under way with some special systems of firing, we requested that, on the occasion of our visit, the boiler should be started up from cold, and found that there had been no fire in it for several days. A few sticks were thrown into each of the gasifiers and lit with oily waste. The pulveriser was then started up and immediately began to supply powdered coal. This fuel burned with a deep orange flame interspersed with sparks, as seen through the secondary air inlets, but not a vestige of black smoke came from the chimney. After the fire had been burning about twenty minutes the sparks in the flame disappeared, and it was evident that the coal was completely gasified before it arrived at the point where the secondary air was admitted. At this stage the lining of the gasifying chamber had become incandescent. The result was a big rolling mass of flame, which appeared to enter the furnace tubes equally throughout their area, while the cloudiness of the gases leaving the smokestack seemed to be caused more by dust than by smoke. In this connection it should be pointed out that the coal being used had, on account of the present trouble in our coalfields, been swept up off the local railway sidings, and consequently contained a very large proportion of incombustible matter.



ARRANGEMENT OF APPARATUS FOR BOILER FIRING WITH GASIFIED COAL

All of this material is not, however, discharged up the chimney, as some 30 per cent. of the total is deposited in the form of slag in the gasifying chamber and is drawn off at the well already mentioned. Its temperature is sufficient to make it flow readily and, so far as we could judge, it contains practically no unburnt carbon. The flue dust does, however, include a proportion of carbon—about 9·2 per cent. of its total weight.

We made no attempt to carry out any quantitative tests on the efficiency of the apparatus, contenting ourselves with a study of its general practicability, but have been provided with the results of an extended test by an independent firm of consulting engineers, from which we give below a few extracts. It should be pointed out, however, in connection with these tests, that the actual boiler in question has been out of regular commission for some time, its lagging is in bad repair and there is probably a considerable deposit of scale on the heating surfaces. It is noteworthy also that during the test the boiler was worked at only 68 per cent. of its rated output.

The coal used for the trial was colliery slack containing a large proportion of dust and had a calorific value (lower value) of 11,493 B.Th.U. per pound. The analysis showed 47·14 per cent. of fixed carbon and 14·78 per cent. of ash. The flue gases contained 13·75 per cent. of CO_2 and the temperature in the smoke-box was 641·8 deg. Fah., while the average temperature in the combustion chamber was 1476·8 deg. Fah. The draught at the bottom of the smokestack was 0·296in. W.G., but must have been very much less at the fire, as there is a tortuous flue for some distance between the boiler setting and the chimney. In these circumstances the following deductions were made from the results of the trials :—

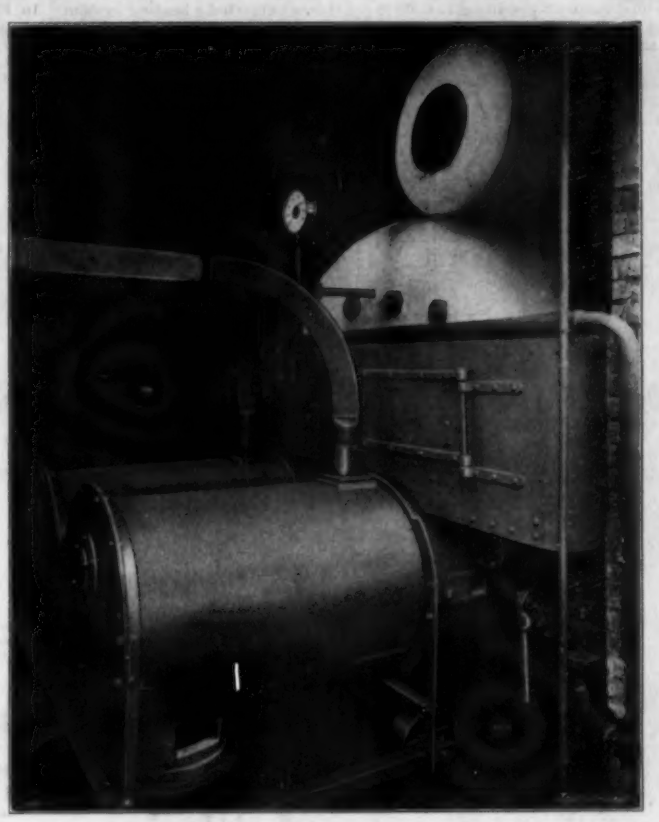
Heat transmitted per square foot of heating surface per hour	3801 B.Th.U.
Weight of fuel fired per square foot of grate per hour	18·52 lb.
Weight of dried fuel fired per square foot of grate per hour*	17·35 lb.
Water evaporated per pound of fuel as fired	7·04 lb.
Equivalent evaporation from and at 212 deg. Fah. per pound of fuel as fired	8·49 lb.
Water evaporated per pound of dried fuel	7·52 lb.
Equivalent evaporation from and at 212 deg. Fah. per pound of dried fuel	9·07 lb.
Equivalent evaporation per pound of carbon value of fuel from and at 212 deg. Fah.	11·48 lb.
Weight of feed from and at 212 deg. Fah. per square foot of heating surface per hour (neglecting moisture in steam)	3·93 lb.
B.O.T. units used per ton of fuel fired (includes magnetic separator)	39·31 kWh.

* Based on the original grate area of 30 square feet when ordinary fire-bars were fitted in the furnace.

The thermal efficiency of the boiler, according to these tests, works out at 76·2 per cent., but it should be pointed out that over and above the handicaps already mentioned no credit is given for the heat lost by radiation from the gasifying chambers, which in future installations will be minimised.

APPARATUS FOR BOILER FIRING WITH GASIFIED COAL

COAL PULVERISER



COAL GASIFYING CHAMBERS

During the progress of the trials just mentioned the patentees made some analyses of the flue gases, and from these it can be deduced that an exceptionally small amount of excess air was introduced into the furnaces. This analysis showed 13·72 per cent. of CO_2, 5·35 per cent. of O_2, and no CO. The carbon carried over into the flues was, as already stated, 9·8 per cent. of the dust.

With all these data as basis the following "heat balance" has been prepared :—

Heat Balance.

	B.Th.U. per lb. of coal as fired.	Per cent. of heat in coal as fired.
1. Heat absorbed by the boiler	8,160	75·5
Heat carried away by :		
2. Dry chimney gases	1,585	14·6
3. Steam from hydrogen in dry coal	386	3·6
4. Steam from moisture in coal	82	·7
5. Carbon monoxide	0	0
6. Radiation and unaccounted for*	603	5·6
Total of lines 1 to 6 and calorific value (net)	10,816	100·0

Air required per pound of coal, 8·59 lb. (1); air supplied per pound of coal (from flue gas analysis), 11·99 lb. (2); excess air (2) — (1) ÷ (1) = 39 per cent.

* By calculation at least 1·5 per cent. is avoidable radiation through non-jacketed gasifier casings.

A noteworthy feature of this system of firing is that it can be quickly adapted for burning oil instead of powdered coal, and it is obvious, if it is satisfactorily applicable to an internally fired boiler, it is available for many other services, such as water-tube boilers and furnaces in general.

A Pass-out Steam Engine.

REGARDLESS of the admitted superiority of the turbine when large units are under consideration, reciprocating engines are still being installed throughout the country for providing power to factories in competition with power supplied by turbines in the great "super-power" stations. It is not, of course, always possible for a reciprocating engine to compete with the steam turbine on a commercial basis, especially where units of, say, less than a thousand horse-power are concerned; but where an opportunity arises of employing part or all of the exhaust from the engine for heating purposes incident to the manufacturing process involved, the high-speed reciprocating engine possesses several merits.

An example of such conditions is found in a paper mill at Otley, Yorks., owned by Messrs. Garnett, which we recently had the privilege of exploring. It is a mill which has an output of about 125 tons of paper a week—mostly of the high-class soft wrapping type—and until a year or so ago was driven by slow-speed engines, while the steam required by the papermaking machines for drying purposes was supplied from a back-pressure engine exhausting against 15 lb.

With the object of improving the efficiency of the works and concentrating both mechanical and electrical drives in one unit the old engine has been scrapped and a new engine has been installed by Belliss and Morcom, of Birmingham, to drive all the machinery and, incidentally, supply the low-pressure steam necessary for the drying cylinders. The outstanding result of the change is that the average coal consumption of the factory has been reduced from some 22¼ cwt. of coal per ton of paper made, to about 17½ cwt., whilst, when making one class of paper and with the machines fully loaded, a coal consumption as low as 15 cwt. per ton of paper has been recorded. It will be seen that an economy of from 22 to 33 per cent. has been effected, and this is in comparison with the original pass-out system of supplying the heating steam. When contrasted with the system of using boiler steam directly the saving is, naturally, much greater, and was proved by closing the pass-out branch of the new engine and supplying the paper machines directly from the boiler. The coal consumption then went up to 26 cwt. per ton of paper.

The requirements of the works are, in round figures, 800 horse-power and 6000 lb. of steam per hour, and this service has to be maintained continuously for five and a-half days a week without any intermission. It is consequently some indication of the reliance which the owners place on the reciprocating engine that there is no stand-by, and we understand that the engine has now kept the mill running for two years without causing any check to the manufacturing process through accidental stoppage.

The engine, of which we give some half-tone illustrations on page 250, together with a general arrangement drawing below—Fig. 2—is a standard Belliss triple-expansion set. It differs from normal practice only in the provision of means for abstracting some of the steam between the intermediate and low-pressure cylinders for heating purposes in the paper machines. The engine is directly connected with a direct-current dynamo of 250 kilowatts capacity, which is arranged between the fly-wheel and the outboard bearing, and beyond this there is a rope pulley for transmitting some 600 horse-power to the main shafting of the pulp beating mill. Between the generator shaft and the rope pulley there is a friction clutch, so that the electric generator can be run without the shafting if necessary. This clutch is noteworthy on account of its comparatively small overall dimensions and the great inertia of the machinery it has to set in motion. For this reason the makers, the Cooper Roller Bearings Company, of King's Lynn, produced the special design illustrated by the line drawing Fig. 1.

As will be seen from this illustration, the clutch comprises a series of radially tapered discs mounted alternately on the driving and driven shafts. The discs are held by feathers and are pressed together to transmit the drive by means of a set of rollers A operated by a sliding sleeve B. Each of the rollers is carried by an arm pivoted to the sleeve at C and works in conjunction with spring buttresses D. The full and dotted lines in the drawing show how, by moving the sleeve inward, the rollers are forced under the curved heads of the spring buffers and the clutch plates are pressed together. The clutch plates are only 27in. in diameter and they have to transmit some 600 horse-power at a speed of 300 revolutions per minute,

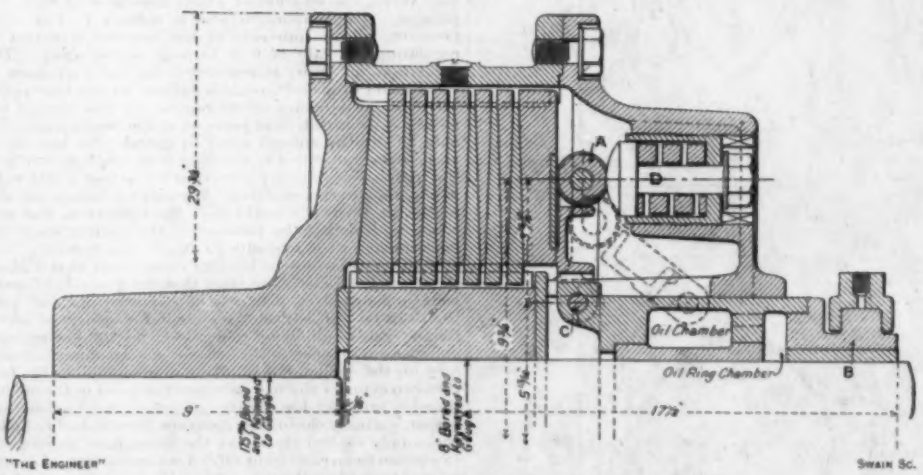


FIG. 1—FRICTION CLUTCH—COOPER ROLLER BEARINGS COMPANY

but the makers and owners tell us that they have had no trouble through the clutch slipping when engaged, or dragging when it was supposed to be free. The clutch casing, by the way, is oil-tight and is filled with lubricant.

The generator, which is of 250 kilowatts, and the rope pulley need little comment, but it should be pointed out that the armature of the generator is bolted directly to the fly-wheel, and the combined weight of the two pieces is carried by two extra large bearings. There are no flexible couplings in the line of shafting and when the clutch is closed the shaft is rigid throughout. Great care had therefore to be taken in lining up the set when it was installed.

The engine, as we have already stated, is a standard Belliss triple-expansion set and has cylinders 18½in., 24½in., and 37½in. in diameter by 16in. stroke. It is designed for an output of 820 brake horse-power normal with or without pass-out, and 875 brake horse-power maximum with pass-out, at a speed of 300 revolutions per minute. It will develop 1000 brake horse-power without pass-out

when being used as an ordinary triple-expansion condensing engine. The steam conditions are 160 lb. pressure at the engine stop valve, superheated 200 deg. Fah. (or a total temperature of 571 deg. Fah.), and 26in. vacuum. The specified pass-out condition is 6000 lb. of steam extracted from the second receiver per hour at 15 lb. gauge pressure. In addition to the ordinary governor and throttle valve; automatic expansion gear is fitted to vary the high-pressure cut-off, and an Area regulator, described later, automatically maintains a pressure of 15 lb. in the heating main. The engine is, of course, equipped with forced lubrication to all its working parts, including the working parts of the governor, on the system originated by the makers in 1890. The condensing plant is of the standard multi-kinetic jet type, comprising a condenser, steam jet air pump and condensate extraction pump operated by belt from the main engine. It is capable of dealing with 9000 lb. of steam per hour and will maintain a vacuum of 26in. with the barometer at 30in., when supplied with 15,900 gallons of circulating water at a temperature of 60 deg. Fah. The condenser and its driving belt are plainly shown in two of our half-tone engravings.

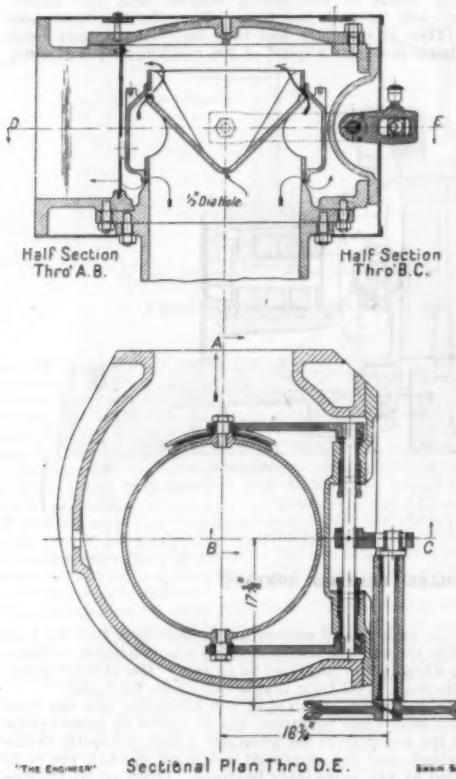


FIG. 3—APPORTIONING VALVE

The arrangements for drawing off the low-pressure steam into the heating range are shown in Fig. 2 and in one of the engravings on page 250, while Fig. 3 is a section through the valve used to regulate the pressure in the heating system. In Fig. 2 it will be observed that the receiver which connects the intermediate and low-pressure cylinders has a branch for passing out the heating steam, and immediately above this there is the apportioning valve shown in Fig. 3. This valve, it will be seen, is of the double-beat type and controls the passage of steam to the low-pressure cylinder. The valve is operated by a wheel over which there runs a chain connected with an Area regulator. The Area regulator was fully described in THE ENGINEER of March 27th, 1925, but it may be as well to indicate here its general principle.

The chain already mentioned is attached to the piston-rod of a vertical hydraulic cylinder, which is plainly shown in one of the half-tone engravings. The other end of the chain carries a counterweight. The cylinder is connected with a supply of pressure water through a balanced three-way valve, the position of which is controlled by a diaphragm. The diaphragm also is subject to the water pressure, but the intensity of the pressure is varied by regulating the rate of flow through a leak-away. This regulation, in turn, is controlled by the expansion or contraction of a little metallic bellows in communication with the low-pressure steam range. In this way, it will be seen, any variation in pressure in the heating main has only to provide enough force to operate the leak-away, and a delicate control is obtained with ample power from the hydraulic cylinder for moving the apportioning valve in the low-pressure receiver. We noticed during our visit to Messrs. Garnett's works that the regulation was very effective, and that the pressure in the heating main was kept steady at the requisite 15 lb. per square inch.

If the pressure in the heating main tends to rise above the normal of 15 lb., indicating that the quantity of steam being exhausted is in excess of requirements and more than can be utilised, the Area regulator opens the apportioning valve, admitting more steam to the low-pressure cylinder, and thence to the condenser. Assuming a steady load on the engine, the resulting extra power in the low-pressure cylinder slightly increases the speed of the engine, thereby bringing the governing mechanism into action, partially closing the governor throttle and reducing the supply of live steam, at the same time moving the expansion to an earlier cut-off. A reverse action, of course, takes place when the pressure in the heating main falls, indicating that the supply of exhaust steam is insufficient to meet the demand. The best possible economy is thus obtained under all conditions.

There may be, of course, occasions when the engine has a comparatively light load, a large amount of heating steam is required and the whole of the exhaust from the intermediate cylinder would go directly to the pass-out branch. The low-pressure cylinder would then be robbed of the lubricating effect of the steam, and to meet this contingency a hole is drilled in the apportioning valve to ensure that there is always a slight passage of steam through the low-pressure cylinder to the condenser.

The official trials of the engine were carried out at the makers' works in the presence of the customers' representatives, and were independently verified by Messrs. Arthur Ellis and Partners, the consulting engineers, of Cardiff. The arrangements made for the test were very complete, the generator being coupled up, but with a hydraulic brake put in place of the rope pulley. Two condensers were used with separate weigh tanks for each, one for the pass-out steam and the other for the steam exhausted by the low-pressure cylinder. The report of the trials of the engine under review states that it ran smoothly and quietly at its rated speed of 300 revolutions per minute under all conditions, both with and without the pass-out in action. The result of the steam consumption tests have been plotted in the form of a diagram, Fig. 4. It will be noted from the diagram that the engine was tested as a plain condensing engine at loads of 600, 820, and 1000 brake horse-power and under the pass-out condition at loads varying from 600 to 875 brake horse-power, and further, that the additional steam required when passing out 6000 lb. of steam per hour over the whole range of load is only approximately 3000 lb., giving a direct saving of 3000 lb. per hour due to the pass-out arrangement.

The fact that the adaptation of the engine as a pass-out engine has not impaired its efficiency under condensing conditions is shown by the following results recorded

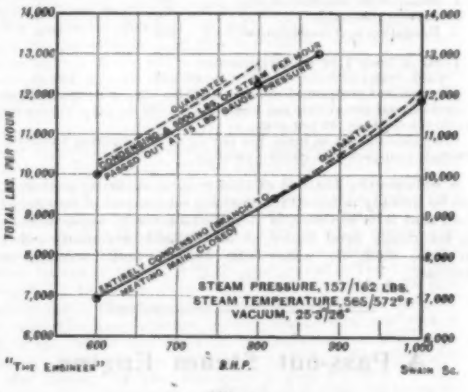


FIG. 4

when exhausting to the condenser with the pass-out branch closed :—Per indicated horse-power hour : three-quarter load, 10·32 lb.; full load, 10·55 lb.; overload, 11·1 lb. Per brake horse-power hour : three-quarter load, 11·57 lb.; full load, 11·46 lb.; overload, 11·82 lb.

If allowance is made for the steam passed out, the steam consumption with 6000 lb. passed out works out to 7·22 lb. per indicated horse-power per hour, at full load and 6 lb. per indicated horse-power at three-quarter load. We are informed that the engine is effecting a saving of nearly £1700 a year as compared with the original system of running the mill.

EDUCATIONAL INTELLIGENCE.

MR. JOHN A. MACARTHUR, B.Sc. (Engineering), Glasgow, at present assistant draughtsman and designer to the Macfarlane Engineering Company and previously with the North British Locomotive Company, Glasgow, has been appointed by the Plymouth Education Committee assistant lecturer in the Electrical Engineering Department of the Plymouth and Devonport Technical College. Mr. Walter G. Green, B.Sc. (first-class honours), London, late Elgar Scholar, now demonstrator in the mechanical testing and metallurgical laboratories at the Royal Naval Engineering College, Keyham, and formerly of the Royal Naval College, Greenwich, has been appointed assistant lecturer in mechanical engineering on the staff of the same institution.

South African Engineering Notes.

New Locomotives and Rolling Stock.

Tenders are now being invited by the Administration of the Union Railways for 42 class G F engines, twenty-one of which are intended for the North and South Coasts and Greytown and Franklin lines in Natal; ten for the Pretoria–Pietersburg line; seven for the Bethlehem–Bloemfontein services; and four for the Balfour North–Bethlehem line. Tenders are also being invited for four class G C A for the Nelspruit–Groskop and Belfast-Lydenburg lines; four class G B for South-West Africa; two class G H experimental main line passenger engines; and two three-cylinder experimental main line engines.

An order has recently been placed with the Groupe Française for seventy-five bogie fruit wagons, delivery of the first ten wagons to be in twenty-seven weeks, and the balance at the rate of fifteen wagons per week thereafter. Consideration is now being given to the building of three special insulated wagons for the better conveyance of chilled meat to Table Bay docks. The design of these trucks will be such that it will no longer be necessary as it is at present, to cut up the sides of beef into quarters, which exposes the ribs and depreciates the value of the meat on overseas markets. In order to provide special facilities for tourists, distinguished visitors, &c., the Railway Board has approved of the building in South Africa of six private saloons, and drawings for the vehicles are now being prepared. It is the intention to make these saloons as up-to-date as possible, and to provide all modern facilities of a reasonable nature. In all probability each saloon will contain four state rooms each with two sleeping berths, and be provided with lavatory equipment, wardrobes, electric fans and bells, wash-basins with hot and cold water, beside electric light switches, and writing tables.

Motor Assembly Factories.

In January of 1914 the Ford Motor Company established a motor assembly plant at Port Elizabeth, and it has now purchased a building site at that town, on which it is intended to erect a factory of modern construction and equipment. The Ford Company was employing 125 hands in December last at the present factory. Another motor assembly factory has just been built at Port Elizabeth by General Motors (S.A.) Ltd., which has now got into full working order, and marks another advance in the history of the motor industry in South Africa. The factory was commenced in April last, and has cost between £300,000 and £400,000 to complete. It is an excellent example of modern organisation, and is conducted on the most progressive lines. The factory is capable of turning out forty-five motor cars a day, and they will comprise Chevrolet, Pontiac, Oldsmobile, Oakland, Buick, Cadillac and Vauxhall cars, and G M C trucks, these being the makes which General Motors controls, but it is intended to concentrate principally at present upon the Chevrolet car. The floor space of the factory is 65,000 square feet, and at one end the bare chassis of the car starts on a conveyor and at the termination of the series of operations it has arrived at the other end a completed car ready to drive away. At the start, the necessary holes having been drilled in the chassis frame work the latter is sent along to the riveters, who drive in the rivets with pneumatic hammers. Braces, fenders, brackets, running-board supports and similar attachments are thus fastened in their places. Each operation is effected as the conveyer passes from point to point. As the frame moves down the track it is turned upside down and the springs and axles are attached. Then follows the petrol tank, which receives a very severe test. The complete motor and transmission are now put into place, and succeeding stages of the assembling brings the exhaust pipe, the carburetter and vacuum tank, until the motor reaches the point where it begins to run under its own power. At this stage the car undergoes the most minute scrutiny by experts. No car is allowed to leave the factory until it has passed an examination and inspection in every detail. While the assembling of the chassis is taking place, another interesting series of operations is engaging workmen at another parallel plant. Here the body of the car is modelled. The body can be followed by the spectator from the skeleton wood frame up to metal sheet attachments, the door panels and the process of spraying by means of which the car receives its coat of paint and varnish, and is dry within fifteen minutes. After this the body is handed to the polishers, and then passes to the trimming and upholstering department. The next trip on the conveyer lands the body in position for the tenting and wiring installation, the fixing of cowl lamps, windshield, speedometer, ammeter, oil gauge, and other accessories. The body gradually takes on the symmetry of stream-lines, and is subsequently hoisted on to the completed chassis to receive the final bolting. Actually only the engine is imported into the Union in any degree of completeness, everything else is done at the factory.

LAUNCHES AND TRIAL TRIPS.

TOLEDO, motor ship; built by Burmeister and Wain, to the order of Wilh. Wilhelmsen of Oslo; dimensions, 375ft. by 52ft. 3in. by 29ft. 7in. Engines, six-cylinder, single-acting Diesel; constructed by the builders; trial trip, July 31st.

LLANDAFF CASTLE, twin-screw passenger steamer; built by Workman, Clark and Co., Ltd., to the order of the Union Castle Mail Steamship Company; dimensions, 490ft. by 62ft. by 42ft. 6in. Engines, two sets of quadruple-expansion; constructed by the builders; launch, August 10th.

CLAM, motor tankship; built by the Netherland Shipbuilding Company; dimensions, 440ft. by 59ft. by 32ft. 9in.; 10,000-tons deadweight. Engines, double-acting four-cycle; constructed by the builders.

CARRONWATER, bucket hopper dredger; built by Ferguson Brothers (Port-Glasgow), Ltd., to the order of the London, Midland and Scottish Railway Company; 1200 tons hopper capacity. Engines, three-crank, triple-expansion type, pressure 180 lb.; constructed by the builders; launch, August 24th.

Nos. 562 G and 568 G, steel lighters; built by Harland and Wolff, Ltd., to the order of Elder, Dempster and Co., Ltd.; dimensions, 71ft. 9in. by 16ft. by 9ft. 4in.; to carry 80 tons deadweight; launch, August 24th.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

General Situation.

THOUGH the weekly market of the Midland iron trade on the Birmingham Exchange to-day—Thursday—was quiet and little new business was transacted, the general tone showed improvement, it being generally held that the industrial position in this area is a little more hopeful than it has been. This district is fortunate in the fact that more miners continue to go back to work, the recent increases at the pits being well maintained. The forges and mills already started continue at work, and there should be increased operations shortly. Most of the Staffordshire ironworks have better order books than for a long time, and with supplies of fuel more plentiful, iron and steel makers and consumers feel more confidence, and booking is more general than has been the case of late. The amount of new work given out is considerable. The builders of rolling stock have good orders, which they would be glad to execute if adequate fuel supplies were available. Taking all things into account, a busy autumn should be assured when normal coal production is resumed. There is little change in the market position of iron and steel. Buyers exercise increased caution, particularly as regards emergency business with continental shippers. The expectation that market tension will be relieved in the near future by a full coal supply from British pits, disinclines consumers to pay extravagant prices for the material which is now available. Moreover, it is generally anticipated that coal prices, in view of the large foreign supplies, may be expected to fall when the pits reopen.

Steel.

Business in steel continues to increase. Those local mills which are in operation find no difficulty in disposing of the whole of their output at profitable prices. Angles make about £8 7s. 6d., an advance of £1 5s. on the price ruling before the coal dispute. Small steel bars are obtainable at £8 10s., though some sellers ask £8 15s. Strip for the tube mills continues to be rolled. Plates are decidedly scarce. With the largest plants idle, engineers' demands cannot be fully met, and many firms are in difficulties, having to curtail working hours. Fairly large supplies of foreign steel are available, but many engineers now complain of the inferior quality of steel bought from abroad. Constructional engineers who have used this material state that under tensile and transverse tests it does not turn out as well as they had anticipated, and a few of them do not propose to continue their works until British steel is again available. Where the requirements are less exacting, however, continental steel continues to be used, despite the fact that it is becoming dearer. The rising tendency of foreign steel is counteracted, to a small extent, by the anxiety of merchants who have bought heavily to unload their stocks before the home steel works resume operations. Users are experiencing difficulty in getting regular supplies from the Continent, deliveries having slowed up. Ten to twelve weeks is commonly named as the period for a new order. The demand for special steels continues excellent, and one large steel works in Birmingham, specialising in tool steels, has operated practically throughout the strike. Some native steel works are stated to be willing to book orders for delivery after the termination of the strike at pre-strike prices. In other cases an advance of 2s. 6d. to 3s. is required. For quick deliveries a premium of about £1 5s. has to be paid.

Pig Iron.

There has been little if any change in the pig iron situation during the week. In spite of the high price Cleveland pig iron is being bought for this district, costing as much as £5 7s. 6d. delivered. There is little activity in Scotch iron, however. The continental pig iron which is now coming forward, has all been sold to the consumer, who is exercising great care to insure that his prospective imports do not exceed the period of the dislocation at home. He expects to be able to buy to better advantage from native sources of supply before the autumn is far advanced. Luxembourg pig for the light foundries is quoted at from £4 10s. to £4 15s. delivered here. Foundries are being carried on with difficulty, and the production of the necessary castings to keep the engine shops at work has become very costly. The founders are finding coke very scarce, and frequently pay as much as £3 10s. to £3 15s. for coke of indifferent quality.

Bar Iron.

Staffordshire bar iron makers have excellent order books, especially those specialising in best grade bars. For the most part, however, they prefer to remain idle until the fuel to which they have been accustomed is once more available. They prefer to postpone operations rather than run risks in the lowering of the product by unsuitable fuel. Nevertheless a few mills continue to turn out fair quantities of material. Lancashire Crown bar quotations have stiffened somewhat, sellers this week asking £13 per ton. Very little business is being transacted, however, though negotiations continue for supplies after the works settle down again in the autumn. Continental No. 3 bars for nut and bolt making are coming into the district in large quantities, but very little new business is being given out. Values remain at £6 2s. 6d. delivered.

Sheet Prices Reduced.

The improved coal supplies have brought into operation more sheet mills. The pressure of demand has eased somewhat, however, and lower prices have been accepted this week. Many mills have reduced their quotations by from 7s. 6d. to 10s. per ton. Supplies for early delivery can now be got at £16 10s. Where immediate delivery from stock is required up to £16 15s. is asked. There is very little activity in tin-plates. Consumers will not buy more than they are obliged to at present prices, and merchants refuse to undertake any risks. A few orders have been placed at about £1 1s. for execution after the coal dispute is out of the way.

Iron Pipe Contract.

A recently placed contract which has some special features is the order obtained by Braithwaite and Co., for 21,000 tons of wrought iron pipes for use in connection with a Brazilian water undertaking. It is unusual to use wrought iron pipes for this purpose; but this material of special quality has been selected because of its superior resistance to corrosion.

Mining Situation.

The steady return of men to the pits in the Midland coalfields continues, and considerable tonnages of coal are being raised. At Cannock Chase, including Pelsall, where about 7500 colliers are at work, approximately 26,000 tons of coal were raised last week. In the Warwickshire area over 7600 men are daily descending the pits, whilst the latest available figures show that in the Nottinghamshire and Derbyshire coalfields at thirty-one pits 9174 men are working, an increase of 2000 on last week's figures. In the West Midland area there are about 900 at work, an increase of some 150 on the previous week. At some collieries so many men have resumed as to make it possible to introduce second shifts. According to the latest official figures, there are now 50 per cent. of the normal number of miners at work in the Brierley Hill district, one or two of the smaller collieries having their full complement.

Cast Iron Research.

Industrialists in this area connected with the British Cast Iron Research Association were relieved and pleased to learn that the Government had decided to renew its grant of £1 for every £1 raised in subscriptions over the next three years, on the understanding that the subscription income shall not fall below £4000 annually. Such good service has been rendered to the industry in the past by the Association that a discontinuance of its operations would have been a great disappointment and an undoubted blow to the progress of cast iron manufacture.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Outlook.

ALL the engineering industries in the Lancashire district are suffering, some more than others, from the coal stoppage, and its effects on supplies of iron and steel. How soon the gradual return of the miners will be sufficient, in the aggregate, to enable a start to be made with iron and steel production on a scale something approaching normal is a question that is exercising many minds at the present time. Certainly, so far as the Lancashire and Cheshire coalfields are concerned, there is little indication at the moment of a movement by the miners to return to work. Apart from one pit in Lancashire and another in Cheshire, the coal mines in the two counties are idle. Generally speaking, the foundries in the Lancashire area are poorly employed, to a large extent because of the scarcity and high price of pig iron. Constructional engineers are similarly handicapped because of the difficulties in the way of securing steel material. With a few exceptions machine tool manufacturers are working much below capacity, and textile machinists are feeling the effect of the hold-up of orders that would otherwise have been placed. Makers of heavy electrical plant continue to be in a relatively satisfactory position, while local locomotive firms will also be in a better position than they have been for a long time when they are able to obtain adequate supplies of steel material. In spite of all the current difficulties with which the industries are faced, Stock Exchange interest in iron and steel and engineering shares is maintained, and most of them are quite firm.

Engineers and Civic Week.

Local general engineering firms, manufacturers of electrical plant, and textile machinists are among the concerns that are actively supporting the "Pageant of Industries" feature of the Manchester Civic Week, to be held early in October. Among the firms which have promised their support are Sir W. H. Bailey and Co., Ltd., Baxendale and Co., Ltd., the Chloride Electrical Storage Company, Ltd., Crossley Motors, Ltd., Etchells, Congden and Muir, Ltd., Ferranti, Ltd., the Ford Motor Company, Ltd., J. Hetherington and Sons, Richard Johnson, Clapham and Morris, Ltd., Mather and Platt, Ltd., Matthews and Yates, Ltd., the Metropolitan-Vickers Electrical Company, Ltd., Platt Bros. and Co., Ltd., S. A. Rhodes, Ltd., T. Robinson and Son, Ltd., Small and Parkes, Ltd., Turner Brothers' Asbestos Company, the British Thomson-Houston Company, Ltd., and the Willys Overland Crossley Company, Ltd.

Non-ferrous Metals.

Fluctuations in the demand for tin during the past week were responsible for sympathetic movements in prices, although on balance there is not much actual difference in the levels of prices to record, except that a slight loss in the case of cash metal and a slight gain in forward positions has reduced the difference between the two. Domestic users of tin have not been important buyers, but with American consumers and those on the Continent taking a fair interest in the metal there has not been much cause for lower values, particularly as the statistical strength of the market, in spite of the fact that available stocks have shown a slight improvement, is regarded by the "bulls" as satisfactory. At the time of writing copper closes quite steady, after a period in which some ground was lost. The position in this section in some respects resembles that of tin, so far as the sources of buying interest are concerned, and if, as is expected in some

quarters, there is an important reduction in stocks disclosed when the August month-end returns are published, a steady course of values may be looked for. Lead keeps fairly steady, prices moving upwards and downwards slightly in accordance with the demand, while spelter, although rather quiet, is in much the same price position as last reported.

Iron.

As was to be expected when one Derbyshire maker took the lead about a fortnight ago, most of the other producers of pig iron in that area have now followed suit in offering deliveries after the blast-furnaces resume production on the basis of 80s. per ton, free on truck, the delivery prices varying from 87s. 6d. to 88s. 6d. per ton in Manchester, according to the position of the furnaces, to 90s. in some of the outside Lancashire towns. At this figure, most of the makers have succeeded in attracting a certain amount of business, but the demand is strictly limited, and hardly any buyer has sufficient faith in the price position to place contract orders on the basis mentioned. What users are anxious about is to get delivery of sufficient iron to enable them to carry on when the coal position is more or less normal again. So far, I have not heard that similar action has been taken by pig iron makers in other districts. There seems to be quite a fair amount of Middlesbrough foundry iron to be bought here this week for prompt delivery, the price quoted being about 105s. per ton, delivered Manchester or equal distance. Scottish No. 3 iron is less plentiful, although offers are still being made at from 105s. to 107s. 6d. per ton, with hematite quoted at 98s. to 98s. 6d. Lancashire bar iron prices are unchanged and nominal so far as prompt delivery is concerned, as none of the works is yet producing. The Association prices of £11 10s. per ton, delivered in the South Lancashire district, for Crown bars and £10 5s. per ton for second qualities are, however, being quoted for forward, although there is not much response on the part of users. Stockholders are, of course, asking much higher prices than those mentioned for delivery out of warehouse.

Steel.

A very small output of joists, sections, and light plates is being produced by British rolling mills, working, of course, on imported fuel and semi-finished material, and this is being offered at prices that are based on the higher costs which makers have to bear. From £1 to £1 10s. per ton more than the official minimum rates is being asked. Small steel bars are also being made under similar circumstances, and are being quoted at about £9 10s. per ton. Whilst there is not much difficulty in placing the material that is being made, buyers are still very diffident regarding forward business, as are also, for that matter, sellers. Higher prices are now being quoted for certain lines of continental materials, particularly joists and plates, although, as there is still a good deal of difficulty in finding continental firms willing to take fresh business, these prices are largely nominal. Ordinary plates are now quoted at £6 7s. 6d. per ton, Siemens plates at £6 17s. 6d. to £7, steel bars at £6, sections at £6 2s. 6d. to £6 5s., joists at about £6, and Belgian No. 3 bar iron at £6 2s. 6d., delivered to works in the Manchester district, for cash against shipping documents. Sellers here are able to report very little inquiry from India, more especially for the 24-gauge sheets, which are quoted at about £16 10s. per ton f.o.b. The Eastern markets for thin sheets are very quiet, but prices are steady at £24 10s. per ton for Shanghais, £24 2s. 6d. for Rangoons, £23 5s. for Bangkoks, and £22 5s. for Straits.

Scrap.

Although there is still very little business being done in scrap metals, non-ferrous materials are steady. Brass rod turnings are quoted at £39 to £40 per ton, cast aluminium at £81, heavy yellow brass at £45, best selected gun-metal at £53, braziery copper at £52, clean light copper £57, lead £31 10s., and zinc £25 10s. for graded qualities, delivered to users' works.

BARROW-IN-FURNESS.

Hematites.

There is no change to report this week in the general position of the hematite pig iron trade of this district. With the whole of the furnaces standing idle, the only iron available for sale is that held in store. The demand is easy, but it is quite likely that there will be a complete clearance by the time the coal strike is settled. At works contracts on local, general, home and overseas accounts are held. A little refined iron is being made in North Lancashire, but the demand is quiet. There is next to no call for charcoal iron at present.

Iron Ore.

With the production of iron at a standstill there is no local call for hematite iron ore, and most of the pits are idle. Some ore, however, is being raised in North Lancashire and South Cumberland. There is no demand for foreign ores.

Steel.

There is no business being done in steel rails and other steel material, and the works at Barrow remain idle. The only activity at Barrow is in the rolling of hoops, for which good orders are held. Steel foundries are also idle.

Shipbuilding and Engineering.

In these trades the activity is well maintained in most departments, and some raw materials have reached Barrow for shipbuilding.

Fuel.

Continental and American coal is being freely imported into Barrow, and is enabling local industries to be kept going as well as the public services.

SHEFFIELD.

(From our own Correspondent.)

Heavy Steel Departments.

Most of the heavy branches of the steel trade have had to come to a standstill, but wherever possible plants have been kept going, regardless of the additional expense that is being incurred. The manner in which Sheffield has survived a coal stoppage of four months is indeed surprising, and every credit is due to the manufacturers for the sacrifices they have made to keep the stream of trade flowing and find employment for as many men as possible. Much ingenuity has been shown in overcoming the natural obstacles that have arisen. It is very difficult to get steel for the heavy trades. Some foreign material is being used, but it is not altogether satisfactory, whilst in many cases it is entirely unsuitable. As I have indicated on several occasions, there is now not much difficulty in getting supplies of fuel, but it is proving expensive and uncertain in quality. Some good Westphalian foundry coke has become available, but the lowest price being asked for it is 65s. a ton, which is about 30s. more than the price that used to be paid for British coke, no supplies of which, by the way, have been available since the strike commenced. Ironfounders have been carrying on with all sorts of substitutes, including blast-furnace coke. Local manufacturers have derived considerable help for limited purposes from the supplies of coke sent out from the works of the Sheffield Gas Company. Unfortunately, but quite naturally, of course, the price has been steadily rising, and a further advance of 5s. per ton has now been made, bringing the price of large coke to 45s. a ton compared with 25s. before the coal stoppage, and the price of breeze to 48s. a ton.

Shipbuilding Items.

Work for the shipbuilding industry has had to stop owing to the inability to get supplies of steel. That is a very serious matter for Sheffield, for some of the shipyards have got tired of waiting and have secured deliveries of the necessary steel from the Continent, which has necessitated the temporary setting aside of the contract provision that only British steel shall be employed. Cammell Laird and Co. have tenders in for a fairly large number of mercantile and naval vessels and a floating dock.

Brightside Foundry.

Speaking at the annual meeting of the Brightside Foundry and Engineering Company, Ltd., Sheffield, Mr. F. W. Firth, chairman and managing director, said that during the year a policy of concentration had been decided upon. They had taken the opportunity of selling the Wicker Works, and the engineering department would be carried on at Ecclesfield. It would be necessary to transfer the registered offices to the Newhall Works, and it was hoped to have the staff installed there in a short time. A matter that gave a great deal of thought was the decision to close down the Carbrook Foundry. They found that they could help themselves by saving a good deal and putting it into Newhall, where there was plenty of room. That was effected in the first week of July, and it had turned out very satisfactorily. They were still suffering very badly from the coal strike and they had still got to meet severe foreign competition. "We are," he added, "repeatedly losing large orders which we have always previously had, on account of the low prices quoted by France and Belgium." Last week, by the way, the Brightside Foundry Company produced from its furnaces at the Newhall Works one of the largest castings ever made in Sheffield. It was a huge ingot, 85½in. by 89½in. by 153in., weighing 110 tons. Blowing at the cupolas began at 11 a.m. and the casting started at 3.28 p.m. The metal was through the risers in six minutes. In the near future the firm hopes to cast a 94-ton and 52-ton anvil block.

Spanish Steel Market.

Sheffield Chamber of Commerce has made strong representations to the Government against the Spanish Royal Decree which practically makes it impossible to export steel to Spain. The effect on the Sheffield steel trade will be very serious. In addition to the Decree prohibiting importation by Spanish merchants, the Spanish Government has given notice to the Swedish Government that the definition of fine and common steels in the commercial treaty between the two countries must be cancelled. Information has just been received in Sheffield that the Swedish Government has consented to that course and that will therefore leave Spain with a free hand to impose duties on the commoner steels. In the opinion of Mr. Albert Law, secretary of the Chamber of Commerce, Sheffield workmen may be called upon to ask the Government for some form of retaliation or protection. The following incident is of interest as showing the fight that Sheffield proposes to put up. Vine growers in Spain often write to the Sheffield Chamber of Commerce asking for the names of wine merchants in Sheffield and district. One such letter was received a few days ago, and the following is the reply sent by Mr. J. H. Chapman, the president of the Chamber:—"I much regret that I cannot give you the information asked for. In view of the Spanish Royal Decree, which hinders and practically prohibits the importation of Sheffield steels into Spain, we are determined not to buy the products of your country until the said Decree has been cancelled. The Decree originated doubtless in the interests of a small group of manufacturers, but we consider it as an unfriendly interference with the steel makers of this country, and hard and unjust towards agents of both countries, who are absolutely prohibited from dealing in steel. A rigorous and intensive propaganda is about to be initiated in the Press so that the public here may abstain from buying the wines, almonds, oranges, &c., of Spain, until this Decree has been modified, which is directed against a country which constitutes one of the best markets of the products of Spain."

Cutlery and Plate.

At last it is possible to report an improvement in the cutlery and plate industries. Numbers of orders have been received during the last week and many of them are of an urgent character. These are belated orders for the seaside trade. The general strike, followed by the curtailed train service, ruined the seasonal trade at the resorts for the time being. Now that holiday traffic has been resumed wholesale and retail houses serving the popular resorts find themselves with exceptionally light stocks, and consequently there is a rush to get delivery of fresh supplies. A good deal of the trade, of course, has been lost, but the seasonal trade has made a much greater recovery than was expected. There are also signs that the Christmas trade is beginning to develop, and there is a much larger call for cutlery, particularly the better-class lines, which are being sought by the Dominions, chiefly Australia. It is fortunate for these lighter trades that they are not large fuel users, and with plenty of gas and electricity available for power and heat the influence of the coal strike is not making itself unduly felt. Darwin and Milner, Ltd., who are making safety razor blades on the mass production principle at Fitzwilliam Works, Tinsley, Sheffield, are getting more orders than they can deal with. The production is now one million blades per week, and preparations are in hand for increasing the output. It is significant that the firm is doing a substantial business with the United States.

Colliery Developments.

There are two items of interest in the mining world to record this week. The strike has not interfered with the sinking operations that are proceeding in the Yorkshire, Nottinghamshire and Derbyshire coalfields. The announcement is made that the Shafton seam of coal has been reached at a depth of 298 yards at the Upton pit of the Upton Colliery Company, Ltd., where sinking operations have been in progress since January last. Two shafts have been sunk. The second shaft is at present down to 253 yards, and it is expected that the seam will be struck at about the same depth as in the first shaft. The quality of the coal is very good, the seam being 3ft. 3in. thick. The shaft is 21ft. in diameter and is lined with concrete blocks. Sinking has been carried out with extreme difficulty owing to the presence of water, to deal with which cast iron tubbing had to be used. The company expects to reach the Barnsley seam at the same depth as the Bullcroft pit, 660 yards.

Sheffield's New Tram and Motor Garage.

Sheffield Corporation is to build at a cost of £100,000 a two-storey tram depôt and motor garage on a site in the centre of the city. The contract for the excavation, which is now in progress, has been given to Wellerman Bros., Ltd., and the second operation, for the concrete work, will be undertaken by Wilkinson Bros., both Sheffield firms. The other contracts have not yet been placed.

Increased Gas Charges.

Following unexpected expenditure caused by the coal stoppage, the Leeds Corporation Gas Committee has recommended an increase in the price of gas from the October reading by 6d. per thousand cubic feet, or 1·28d. per therm. At the annual meeting of the Barnsley Gas Company it was reported that the new water gas plant had been invaluable in the crisis. Water gas was much more costly to make than coal gas, but had it not been for its help they would have had to cut off the supply some weeks ago. Foreign coal had had to be bought for gas-making purposes. It would cost at least three times the normal amount. To meet this increase the Committee will have to charge its maximum legal limit per therm after the September reading.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Position.

THE trade position in the North of England has undergone very little change from last week. Having regard to the difficulties that have to be surmounted, it is remarkable that so much is being done, and with ample supplies of fuel now arriving, preparations are being made to put more idle plant into operation. Although the end of the coal trouble cannot be definitely forecast, there is a general opinion in the North that it is not far off, and that district settlements will provide the way to peace. Another fairly large colliery in Northumberland is expected to start work next week on an eight-hour day and 10 per cent. reduction in wages. Other collieries have been in negotiation with their workmen with a view to restarting, but nothing has been settled as yet. In the absence of greater competition, the pits in the county that are working are, of course, doing well. The coal is fetching a good price, and the men are getting good wages. The improved prospects of a settlement of the coal dispute have led to a fair number of inquiries in the iron and steel trade this week, and it is understood that orders have been booked for delivery a few weeks after work is resumed at the pits.

Cleveland Iron Trade.

Business in the Cleveland pig iron trade still continues on a very limited scale. Interest centres largely in possible market movements after the termination of the coal dispute, the general opinion being that values will show a considerable fall. Seldom, if ever, has the statistical position of the industry been stronger. Stocks have all but disappeared, and most of the producers have considerable arrears of deliveries to overtake through unavoidable suspension of production. This week a further advance of 6d. per ton has been made in Cleveland pig iron prices, but the total output of iron is so small that the advance makes little difference. It does indicate, however, that manufacturers are in a strong position, and are quite readily selling any iron they have to dispose of. But the fact remains that British consumers are now largely dependent on foreign sources of supply, and imports are still

substantial. Continental pig iron prices are advancing, but are still far below Cleveland quotations, and the latter will have to fall substantially before makers can hope to compete. There is, however, a firm confidence that there will be brisk business when the miners get back to work, and buyers are offering forward contracts. No. 1 Cleveland foundry iron is now quoted at 93s.; No. 3 G.M.B. Cleveland pig iron, 90s. 6d.; No. 4 foundry, 89s. 6d.; and No. 4 forge, 89s. per ton. These are home prices, and nominally export prices are 6d. per ton more, but there is no foreign business now.

Hematite Pig Iron.

There is little new to report concerning the East Coast hematite pig iron trade. Only one firm is now producing hematite in this district, and other makers have little or nothing to sell. Still it is not so scarce or as dear as Cleveland foundry iron, the price of mixed numbers remaining unchanged at 82s. 6d., and No. 1 quality at 83s. per ton.

Ironmaking Materials.

Fuel supplies are much more plentiful, but the price is far too high for manufacturers to restart plant on an extensive scale. Up to 50s. per ton c.i.f. is asked for good furnace coke. The foreign ore trade is in a lifeless condition. Best Rubio is nominal at 21s. 6d. per ton c.i.f. Tees.

Manufactured Iron and Steel.

Small lots of manufactured steel are being sold, and in all the circumstances there is a surprising amount of activity at the heavy steel rolling mills. But this is to meet specially urgent orders at special prices. Sales are still being made from stock. The galvanised sheet mills, which have continued in operation throughout the coal dispute, are very busy, and orders continue to come forward in good volume. Prices of all finished steel materials show a marked upward tendency.

The Coal Trade.

There is a strong feeling that the week-end will see substantial developments in the coalfields and the reopening of many additional pits; but unfortunately the outlook in Northumberland and Durham is not encouraging, and traders think that the men in those counties will be the last to resume. In view of an anticipated busy time when the stoppage is over, there is a little more eagerness to test the feeling of colliery fitters as to what their ideas of prices are for delivery a few weeks after the pits reopen. In a general way they seem to be fairly high, but merchants are not disposed to buy as yet. Speculators are offering at less than the collieries, perhaps by a shilling per ton. Best Northumberland steams are talked about at 19s. to 20s. per ton, with secondary qualities at 17s. 6d. Best smalls are similarly mentioned at 11s. 6d. to 12s. It is said that some gas coal fitters are asking up to 22s. for best gas coal, but there is no business to give any trustworthy estimate of values.

SCOTLAND.

(From our own Correspondent.)

Clyde Shipbuilding.

OWING to the continuance of the coal strike the output in the shipbuilding industry is seriously delayed. Some builders with contracts on hand sufficient to ensure employment for twelve months ahead have not been able to report progress and many vessels have not yet been laid down owing to the difficulty in securing steel and iron materials. At one yard, for instance, there is only one vessel on the stocks ready for launching, while the builders have orders for a dozen; while at another establishment not one keel out of orders for six vessels has yet been laid down. Other firms are in a similar position. During the month of August eight vessels of 31,970 tons aggregate were launched on the Clyde, bringing the total for eight months up to 100 vessels of 203,419 tons aggregate, showing a drop of 53 vessels and almost 200,000 tons compared with the same period in 1925. The vessels launched during August were as follows:—Raleighstar, twin-screw geared turbine, 10,650 tons, for the Blue Star Line, Ltd., London; Pulpit Point, oil tanker, 8620 tons, for the Vacuum Oil Company, Ltd., London; Yomah, motor ship, 5000 tons, by Messrs. Denny, Dumbarton, to their own account; Koolinda, 4100 tons, twin-screw motor ship, for the Government of Western Australia; Dolores De Urquiza, twin-screw motor train ferry, 2250 tons, for the Entre Rios Railway, Buenos Ayres; and two lighters and a bucket hopper dredger, the former each of 50 tons, for Elder, Dempster and Co., Ltd., Liverpool, for service in West Africa. Contracts announced during August included the following:—William Hamilton and Co., Port-Glasgow, to build an oil tanker for H. E. Moss and Co., Liverpool, and a general cargo steamer for foreign owners; Lithgows, Ltd., Port-Glasgow, a cargo steamer for Turner and Co., London and Liverpool, and a cargo steamer of 8000 tons deadweight for other owners; and Ferguson Brothers, Port-Glasgow, two hopper barges, each 170ft. in length and costing altogether £58,000, for the Government of Queensland.

Steel and Iron.

The situation in the steel and iron trades has not undergone any change of note during the past week. Few works are in operation and the small output available is readily disposed of at firm prices. Though very little steel has been made, bookings are said to be considerable. Steel sheet makers report a steady demand for black and galvanised varieties and extended deliveries are now the rule. Buyers of continental sheets are now being faced with protracted deliveries owing to transport delays. Bar iron continues firm, supplies being limited, and re-rolled steel is similarly placed. The production of pig iron being at a standstill and stocks extremely low, the upward tendency of prices is still evident. No. 1 quality pig iron is practically unobtainable.

Miners Breaking Away.

While it is estimated that only some 6000 miners are at work in Scotland, it is becoming increasingly evident that many more are desirous of returning to their jobs and are only restrained by lack of example or strong picketing. No move at all has been made in some districts, but the situation in Lanarkshire is more hopeful at the moment, while there is a reported break-away of miners in Clackmannan. Considerable quantities of fuel are being secured from outcrop working and not all of those thus employed are miners or belong to the districts interested. The sale of outcrop coal has become so extensive in one district in Ayrshire that a meeting of the Miners' Union has been called to deal with the matter.

Foreign Coal.

The market for foreign coal has fluctuated considerably during the past week or so owing to varying reports from home coalfields. At the moment, however, consumers are more disposed to book ahead and prices are firm as follows:—American unscreened, 47s. 6d.; Westphalian unscreened, 47s. 6d.; and Silesian screened, 50s., all per ton f.o.t. Glasgow.

Dearer Coke.

Owing to a rise in the price of coal the Glasgow Emergency Committee found it necessary to increase the price of coke to 40s. per ton.

Scottish Patent Fuel.

Scottish patent fuel is quoted about 47s. 6d. per ton, f.o.b. at Glasgow, Bo'ness and Grangemouth, and 48s. 6d. at Leith.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Dispute Outlook.

HOPES ran high at the end of last week regarding the prospects of an early settlement, but since then they have somewhat receded. It was thought that the miners' leaders were in a more conciliatory mood; but as they have not given way one bit on the vital points at issue, very little progress, if any at all, has been made. At the same time the feeling is prevalent that in the course of this week and next there will be developments, as it is becoming realised to a greater extent that if a settlement is not arrived at by the leaders very soon, the rank and file will take matters into their own hands and return to work on a much larger scale than hitherto. In South Wales reports have come to hand that a number of men have resumed work. The total number is not very considerable in comparison with the miners who are idle, but it is a beginning. A number of men signed on for work at a colliery in the Pontypool area on the basis of a 46-hour week, viz., eight hours per day except Saturday, when six will be worked, but their action has been followed by a certain amount of trouble in the district, as the other miners have resented the action of the returning men, and the police have had to intervene and use their batons. Miners employed at the Copper Pit Colliery, Morriston, Swansea, declined on Saturday to accept the offer of the company to return to work. The company's offer was to reopen the colliery on a 46-hour week at the rate of wages that applied on April 30th, the only difference being that the piece workers would lose the 14·2 per cent. granted when the Seven Hours Act came into force. This pit normally employs about 400 men. The Crynant Colliery Company, near Neath, has also made another offer to its workmen, the offer being a 5 per cent. increase in wages and a guarantee of six months' work on the new rate for an eight-hour day. This offer the men have refused.

S. W. M. F. and Safety Men.

During the latter part of last week a number of lodges, not only in the Rhymney Valley but in other districts, advocated that the executive of the South Wales Miners' Federation should take action to call out the safety men immediately. The executive met on Friday to consider the position generally and to hear a report of its general secretary, who is one of the three representatives on the national executive, but nothing came of the proceedings so far as adopting the course advocated by many of the miners is concerned, one member of the executive describing the proposal to bring out the safety men as a policy of despair. Evidently the executive is opposed to such a reckless suggestion as to bring out the very men upon whom depends so much, as their absence would mean that collieries would soon become flooded.

Conditions of Trade.

Foreign coal continues to come in steadily at local ports, over 60,000 tons being received last week. There are now about twelve to fifteen steamers discharging, but there are not so many cargoes due to arrive. Business in continental and American coals is not now so active, and importers are more cautious than ever in case the stoppage of work in this country comes to an early termination. There are still inquiries for very prompt cargoes of coal, but owing to continental producers being so fully booked up, it is practically impossible to secure coals, and consumers on this side are not prepared to purchase for backward delivery. So far as the general trade at the docks is concerned, it is rather quiet. In the timber section there has not been so much activity, but imports of partly manufactured iron and steel goods have recently increased to an appreciable extent.

Co-operative Selling.

The Swansea Chamber of Commerce considered last week the question of co-operative selling of coal, but decided that any form of it, the result of which would be artifically to increase the price of coal, would be prejudicial to all industries of the country which depends so largely upon unlimited supplies of cheap fuel. The Chamber's opinion is that unrestricted output, with accompanying low prices, will not only succeed in regaining old markets but create new ones, and is the only method of restoring the prosperity to the coal industry to the benefit ultimately of the workers and the coal owners.

Substantial Newport Contract.

Messrs. Braithwaite and Co., who are constructional engineers and owners of the Neptune Works, Alexandra Docks, Newport, have obtained an important Government contract from one of the South American States for between 21,000 tons and 22,000 tons of riveted steel water pipes. To be able to discharge this contract Messrs. Braithwaite have to extend their Neptune Works, and the work is to be taken in hand at once. The pipes have to be delivered in six months.

Tin-plate Trade.

The Joint Standing Committee of the Industrial Council for the Welsh sheet and tin-plate trade has extended the granting of the *ex-gratia* bonus of 7½ per cent. to cover the three months ending November 6th. This bonus has been renewed every three months by the tin-plate employers for a period running to over three years, but it is now understood that the employers have definitely declared that it is their intention to discontinue its operation at the end of the present period of three months. This bonus is stated to be equivalent to about 6d. in the £ on wages.

Steel Tube Trade.

Considerable interest has been aroused by the announcement that, as the result of conferences in London and Dusseldorf between representatives of the British Mannesmann Tubé Company, Ltd., and the Mannesmannroehren-Werke A.G., arrangements have been concluded for the interchange of technical information and assistance with general co-operation. The British Mannesmann Tube Company has works at Swansea and Newport, and it is hoped that the arrangement entered into means, when labour troubles in the coalfield are at an end, a revival of trade activity generally and special benefit in the case of weldless steel tube undertakings.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

LA SOCIETE ANONYME ALFRED HERBERT asks us to announce that it has changed its address from 47, Boulevard de Magenta, Paris, to 1 and 3, Rue de Delta, Paris (IXe).

MR. H. B. CLARKE, A.M.I.E.E., has resigned his position of chief engineer to British Glues and Chemicals, Ltd., to become managing director of Modern Factory Equipment, Ltd., Nottingham.

WE are asked to state that Mr. Alan Williams, M.I.E.E., has been appointed by Vickers Boiler Company, Ltd., Broadway Buildings, Westminster, S.W. 1, sales representative for the South of England in connection with industrial boiler installations and export business.

CONTRACTS.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., has obtained a six months' contract from the Southern Railway for the supply of Mazda electric lamps.

THE GENERAL ELECTRIC COMPANY, Ltd., has received an order to supply and fit an "Express" electric passenger lift in Mukden. It will, it is believed, be the first lift of its type to be installed in Manchuria.

HENRY BERRY AND CO., Ltd., of Leeds, have received an order for twenty sets of special high-pressure three-throw horizontal hydraulic pumps from Synthetic Ammonia and Nitrates, Ltd., Billingham, Stockton-on-Tees.

THE WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, Ltd., has received an order from the Metropolitan-Vickers Electrical Company, Ltd., for 101 motor-driven air compressors, type DH, for the Sydney Suburban Railways extension.

THE DUBLIN DOCKYARD COMPANY (Vickers Ireland, Ltd.), has received an order from the New Zealand Government for a motor vessel for the Pacific Islands Administration. Her dimensions will be 210ft. by 35ft. by 16ft., and the main propelling machinery will consist of twin Vickers-Petters semi-Diesel "C" type heavy oil engines, each developing 600 brake horse-power. The same company has also received an order from the Commissioners of Irish Lights for a twin-screw vessel with dimensions 190ft. by 32ft. by 15ft. 9in., the machinery of which will consist of two sets of triple-expansion engines, with two single-ended oil-fired Scotch boilers.

THE INSTITUTION OF MINING ENGINEERS.—It is announced that the summer meeting of the Institution of Mining Engineers, originally fixed to be held at Newcastle-upon-Tyne in June last and postponed to a date in the autumn, will not be held, owing to the still-continuing stoppage in the coal industry.

INSTITUTION OF FUEL ECONOMY ENGINEERS.—We are informed that Sir Alfred Mond has accepted an invitation to become the first president of the Institution of Fuel Economy Engineers. This news is of more than ordinary interest in view of the fact that Sir Alfred has recently accepted the chairmanship of the new National Fuel and Power Committee appointed by the Government in accordance with the recommendation of the Coal Commission. The first meeting of the 1926 winter session of the Institution of Fuel Economy Engineers will be held on Friday, September 24th, at 6 p.m., in the Lecture Theatre of the Royal Society of Arts, John-street, Adelphi, London, when Dr. A. E. Dunstan will read a paper on the subject of "Liquid Fuels."

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	18/6 to 21/-
(1) Spanish	18/6 to 21/-
(1) N. African	18/6 to 21/-
N.E. COAST—	
Native	—
Foreign (c.i.f.)	21/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	4 2 6	—
No. 1 Foundry	4 15 0	—
No. 3 Foundry	4 10 0	—
N.E. COAST—		
Hematite Mixed Nos.	4 2 6	4 2 6
No. 1	4 3 0	4 3 0
Cleveland—		
No. 1	4 13 0	4 13 6
Silicious Iron	4 13 0	4 13 6
No. 3 G.M.B.	4 10 6	4 11 0
No. 4 Foundry	4 9 6	4 10 0
No. 4 Forge	4 9 0	4 9 6
Mottled	4 8 6	4 9 0
White	4 8 6	4 9 0
MIDLANDS—		
(2) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
" " Foundry	4 7 6	—
(2) Northampton—		
Foundry No. 3	3 5 0 to 3 10 0	
" Forge	2 16 0 to 2 17 0	
(3) Derbyshire—	*(None offered.)*	
No. 3 Foundry	3 7 6 to 3 15 0	
Forge	3 2 0 to 3 5 0	
(3) Lincolnshire—	*(None offered.)*	
No. 3 Foundry	3 5 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 8 8 (a); 4 12 0 (b); 4 16 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	11 10 0 to £12	11 0 0
Best	—	—
N.E. COAST—		
Common Bars	11 5 0	—
LANCS.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	—
S. YORKS.—		
Crown Bars	12 10 0	—
Best Bars	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—	*(Prices nominal.)*	
Crown Bars	11 5 0 to 11 10 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 5 0 to 10 10 0	
Gas Tube Strip	12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	11 0 0	—
Ship Plates, ¼in. and up	7 17 6	7 0 0
Sections	7 7 6	6 5 0
Steel Sheets, under 3/16in. to ¼in.	11 5 0 to 12 5 0	
Sheets (Gal. Cor. 24 B.G.)	—	£17 5 0 to £18 5 0

STEEL (*continued*).

N.E. COAST—	Home. £ s. d.	Export. £ s. d.
Ship Plates	8 0 0	—
Angles	7 10 0	—
Boiler Plates	11 10 0	—
Joists	7 10 0	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 0 0†	—
Light Rails	8 5 0 to 8 10 0	
Billets	8 0 0 to 11 10 0†	
MANCHESTER—		
Bars (Round)	9 5 0	—
" (Small Round)	10 0 0	—
Hoops (Baling)	11 0 0	11 0 0
" (Soft Steel)	10 15 0	10 15 0
Plates	8 2 6	—
" (Lancs. Boiler)	11 10 0	—
SHEFFIELD—		
Siemens Acid Billets	10 0 0	—
Bessemer Billets	11 0 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	7 5 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
MIDLANDS—		
Small Rolled Bars	7 15 0 to 8 10 0	
Billets and Sheet Bars	6 2 6 to 6 7 6	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 10 0 to 16 15 0	
Angles	7 7 6 to 8 17 6	
Joists	7 7 6 to 8 17 6	
Tees	8 7 6 to 9 17 6	
Bridge and Tank Plates	7 17 6 to 8 15 0	
Boiler Plates	11 0 0 to 11 15 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	20/- to 24/-
Block Tin (cash)	295 5 0
" (three months)	291 15 0
Copper (cash)	59 2 6
" (three months)	59 17 6
Spanish Lead (cash)	33 5 0
" (three months)	32 11 3
Spelter (cash)	34 12 6
" (three months)	34 12 6
MANCHESTER—	
Copper, Best Selected Ingots	66 12 6
" Electrolytic	67 17 6
" Strong Sheets	90 0 0
" Tubes (Basis Price)	0 1 1
Brass Tubes (Basis Price)	0 1 0
" Condenser	0 1 2½
Lead, English	33 17 6
" Foreign	32 7 9
Spelter	34 12 6

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10½ per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 10 0	7/6
" 6 p.c. to 8 p.c. "	£22 0 0	7/3
" 8 p.c. to 10 p.c. "	£20 15 0	6/6
" Specially Refined		
" Max. 2 p.c. carbon	£38 10 0	12/6
" " 1 p.c. "	£44 10 0	15/-
" " 0·70 p.c. carbon	£54 10 0	17/6
" " carbon free	1/5½d. per lb.	
Metallic Chromium	3/3 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
" Silicon, 45 p.c. to 50 p.c.	£10 7 6 scale 5/- per unit	
" " 75 p.c.	£20 10 0 scale 6/- per unit	
" Vanadium	15/- per lb.	
" Molybdenum	5/9 per lb.	
" Titanium (carbon free)	0/11 per lb.	
Nickel (per ton)	£170	
Cobalt	10/- per lb.	
Aluminium (per ton)	£112	

FUELS.

SCOTLAND.

(Prices nominal.)

LANARKSHIRE—	Export.
(f.o.b. Glasgow)—Steam	15/9
" " Ell	16/6
" " Splint	16/6 to 17/-
" " Trebles	15/9
" " Doubles	14/- to 14/6
" " Singles	13/9
AYRSHIRE—	
(f.o.b. Ports)—Steam	16/9
" " Jewel	17/- to 17/6
" " Trebles	17/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 14/9
Screened Navigation	21/-
Trebles	14/- to 15/-
Doubles	14/-
Singles	13/- to 13/6
LOTHIANS	
(f.o.b. Leith)—Best Steam	14/- to 14/3
Secondary Steam	13/6
Trebles	14/6 to 14/9
Doubles	13/6
Singles	13/6

ENGLAND.

(3) N.W. COAST—	
Steams	*No quotation.*
Household	" "
Coke	" "
NORTHUMBERLAND—	
Best Steams	16/-
Second Steams	14/6 to 15/-
Steam Smalls	6/- to 8/6
Unscreened	13/- to 13/6
Household	20/- to 22/-
DURHAM—	
Best Gas	18/6 to 19/-
Second	15/- to 15/6
Household	20/- to 22/-
Foundry Coke	18/- to 20/-

SHEFFIELD	Inland. (*Nominal: none on offer.*)
Best Hand-picked Branch	31/- to 34/- —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	26/- to 28/- —
" " House	24/- to 25/- —
" " Large Nuts	17/- to 20/- —
" " Small	12/6 to 14/- —
Yorkshire Hards	17/- to 19/6 —
Derbyshire Hards	16/- to 19/- —
Rough Slacks	10/- to 12/6 —
Nutty Slacks	7/6 to 9/- —
Smalls	3/6 to 6/- —
Blast-furnace Coke (Inland)*	— —
" (Export)	f.o.b. 16/- to 17/-

(9) SOUTH WALES.

(All prices nominal.)

CARDIFF— Steam Coals:	
Best Smokeless Large	26/- to 27/-
Second " "	24/6 to 25/6
Best Dry Large	24/- to 25/-
Ordinary Dry Large	21/- to 22/-
Best Black Vein Large	25/6 to 26/-
Western Valley Large	24/6 to 25/-
Best Eastern Valley Large	24/- to 25/-
Ordinary " "	23/6 to 24/-
Best Steam Smalls	17/- to 18/-
Ordinary "	16/- to 17/-
Washed Nuts	19/- to 20/-
No. 3 Rhondda Large	26/6 to 27/-
" " Smalls	18/- to 18/6
No. 2 " Large	24/- to 25/-
" " Through	20/- to 21/-
" " Smalls	15/- to 16/-
Foundry Coke (export)	40/- to 50/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	42/6 to 45/-
Pitwood (ex ship)	26/6 to 27/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	39/- to 40/-
Seconds	32/6 to 35/-
Red Vein	27/- to 29/-
Machine-made Cobbles	47/6 to 50/-
Nuts	47/6 to 50/-
Beans	42/6 to 44/-
Peas	23/- to 25/-
Breaker Duff	7/6 to 8/-
Rubbly Culm	12/6 to 13/6
Steam Coals:	
Large	22/6 to 24/6
Seconds	20/- to 22/-
Smalls	11/- to 15/-
Cargo Through	16/6 to 17/6

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayreshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market 17/6 to 19/- at ovens. † Latest quotations available. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham.

French Engineering Notes.

(*From our Correspondent in Paris.*)

The Steel Union.

THE Belgian Government is so strongly impressed with the necessity of doing everything to complete negotiations for the constitution of the Steel Union that it is making special efforts to induce the three dissenting firms, Providence, Sambre et Moselle, and Métallurgique du Hainaut, to accept the terms offered. Unless the opposition of these firms can be overcome it is feared that the negotiations may break down, for it appears that a definite decision must be come to at the meeting to be held on September 17th, and if the Belgians fail to subscribe to the conditions the whole edifice, which has been patiently built up, will fall to the ground. It will put an end to the attempts that are being made to reorganise the economic situation of Europe, and will bring about an over-production and a cutting of prices which will certainly prove ruinous for the iron and steel trades. The German proposition upon which the Cartel is based provides for a European production of 26,000,000 tons, which may be increased to 30,000,000 tons, and it will be distributed in the proportion of 43·18 per cent. to Germany, 31·19 per cent. to France, 11·63 per cent. to Belgium, 8·23 per cent. to Luxemburg, and 5·77 per cent. to the Saar. There was at first some difficulty with the steel makers in the North of France, who claimed a participation proportionate to their capacity of production when the works now under construction are completed, and it was finally decided to take as a basis for the respective quotas the production during the first quarter of 1926, which favoured France at the expense of Germany. The Belgian steel makers, however, are not satisfied with their share in the production and want to base the quota upon the production figures for the second quarter of 1926. The successful carrying out of the Steel Union depends solely upon the attitude of the three firms named. On account of the difficulty of conciliating conflicting interests the conditions under which the Cartel is to be formed are fairly elastic, and the only method adopted to ensure that the production attributed to each country is not exceeded is the payment to a common fund of a dollar for each ton of steel produced. For every ton above the quota the amount paid will be four dollars, while should a country not reach the allowed total it will receive a bonus of two dollars on every ton falling short of that total. After deducting expenses the fund will be distributed annually amongst the various countries in proportion to their quotas. Those countries which exceed their allotted production will therefore be penalised in a way that will probably render it difficult for them to dispose of the surplus. At the same time, as a precaution against competition from countries with depreciated currencies, it is agreed that no country will sell in another at below the prices there ruling.

Trade Inactivity.

A rational organisation of European industry is of particular interest to French manufacturers now that they are beginning to experience the preliminary symptoms of an economic upheaval. They see that the danger arising from a too rapid deflation of the franc can only be avoided by international agreements regulating production and prices, and that trade stability can only be effected immediately by the constitution of steel, rail, and other Cartels. Although the franc has remained with little fluctuation for some time past, there is nothing to warrant a belief in its relative stability, and the situation has not been improved by the steadily advancing costs, which are introducing a very disquieting element in the future of trade. So long as there is an idea that the franc will undergo a steady and systematic deflation everyone abstains from buying, and while makers do not anticipate a serious industrial crisis, they believe that they will not be able to pass through what will certainly be a very trying period without some international adjustment of prices.

Colonial Development.

Another factor in the industrial organisation of the country is the importance which the Government is now giving to the development of the colonies as a means of supplying practically all the requirements in raw material. The various means by which that can be done are now being discussed, and while it is obviously out of the question to provide the huge sums necessary for developing the colonial resources, the work already done in some of the colonies is nevertheless giving sufficiently profitable results to permit of a fairly large sum of money being devoted to the purpose. The Government of the French Congo has been authorised to raise a loan of 300 million francs to complete the railway between Brazzaville and Pointe-Noire, where it is expected that the concrete wharf, with an ample depth of water for large vessels, will be ready in 1927. Pointe-Noire is utterly devoid of natural facilities, and even fresh water will have to be brought from a long distance. The Brazzaville Railway was begun in 1914 with a loan of 93 million francs. It was started at both ends, and 200 kiloms. have been laid out of a total of 533 kiloms. Roads have had to be constructed for a motor lorry service to permit of the lines being extended until they join. In a report presented to the Senate it was remarked that the Brazzaville-Pointe-Noire Railway could be electrified by means of the ample hydraulic power available, and that the necessary work could be done before the line was entirely completed in six years time.

The Navy.

The 10,000-ton cruiser Tourville, which was put on the stocks in May, 1924, has been launched at Lorient. With turbines developing 120,000 horse-power, it is expected to attain a speed of 33 knots. Its armament will consist of eight 203 mm., eight 75 mm., and eight 37 mm. guns. The torpedo boat Ouragan, with a displacement of 1455 tons and propelled by geared turbines developing 35,000 horse-power, attained a speed in its trials of 34·6 knots. She is one of twelve similar boats built in private shipyards.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

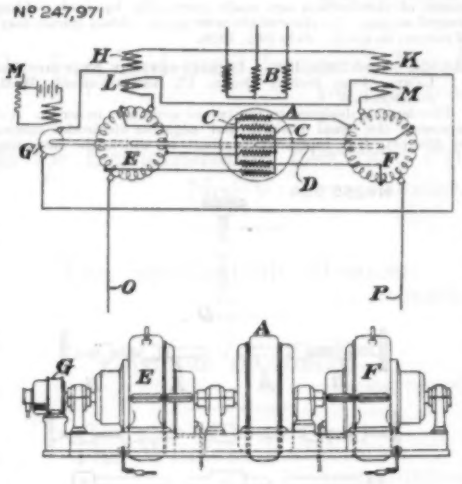
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TRANSFORMERS AND CONVERTERS.

247,971. February 18th, 1926.—IMPROVEMENTS IN OR RELATING TO APPARATUS FOR CONVERTING ALTERNATING ELECTRIC CURRENT INTO DIRECT CURRENT, *Metropolitan-Vickers Electrical Company, Ltd., of 4, Central-buildings, Westminster.*

The object of this invention is to provide a practical 3000-volt converting unit which shall meet the rigid requirements of railway service, and which shall present economies in weight and cost, as compared to the equivalent motor generator set which has heretofore been uniformly adopted for such service. The invention comprises an induction motor A having a stator member carrying a polyphase primary winding B and a rotor member carrying two separately insulated polyphase secondary windings C. Mounted upon the shaft D of the induction motor are two rotary converters E and F and an exciter G. The rotary converters are not provided with slip rings, as they are energised directly from the respective secondary windings C of the induction motor. The rotary converters are excited by means of field windings H and K respectively, and series field windings L and M. The field windings H and K are connected in series

Nº 247,971

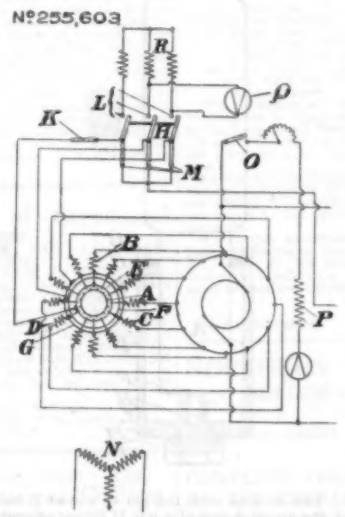


across the armature of the exciter G, the excitation being controlled by means of a rheostat M in the field circuit of the exciter. The series windings L and M are connected in series with the direct-current brush terminals of the rotary converters, and the two direct-current output circuits of the two rotary converters are connected in series to energise a direct-current line O P, the voltage of which is equal to the sum of voltages of either converter. By the construction described it is possible to convert from a rather high alternating-current voltage to a direct-current voltage in the neighbourhood of 3000 volts without resorting to transformers, and without encountering any difficulties whatsoever in the commutation of the rotary converters. It is feasible to insulate the primary winding of an induction motor for voltages as high as 11,000 volts or more, and hence the unit comprising the invention may be directly connected across the alternating-current feeder line. In the set illustrated in the drawing the number of poles is the same in all three machines, namely, six, so that with a 60-cycle supply the set operates at 600 revolutions per minute.—*July 29th*, 1926.

255,603. June 9th, 1925.—IMPROVEMENTS IN STARTING ARRANGEMENTS FOR ELECTRIC MOTOR CONVERTERS, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C. 2, and Max Ludwig Kahn, of the General Electric Company, Ltd., Witton Engineering Works, Witton, Birmingham.

This invention relates to a method of starting and synchronis-

Nº 255,603



ing motor converters of the kind which are so constructed that the two parts of the machine working in cascade are each arranged with the same number of poles, and has for its object to provide an improved method of synchronising such machines. The rotor phase windings of the alternating current part of the machine may be open circuited or they may be short circuited at their inner ends by a switch device A and phase windings B, C and D are respectively joined to slip rings E, F, and G co-operating with brushes which are joined by conductors to the poles of the switch H. When it is desired to start the converter the switch device A is put in the open position and the switch K is closed. Switch H is moved to close contacts L and to open contacts M. The alternating current is then switched on to stator winding N and the machine starts to run up to speed. When the converter reaches a speed approximating to half the synchronous speed of the alternating current part of the converter, switch K is opened, whereupon the machine tends to run at a speed substantially equal to one-half the synchronous speed of the alternating current part of the converter. Switch O is then closed so that the field P is correctly excited, and the machine synchronises, the moment of synchronism being indicated by the voltmeter Q. Thereupon switch K may be closed and the switch device A may be moved to short-circuit the inner ends of the rotor phase windings. Switch H may be moved to close contacts M and to open contacts L, and the direct-current voltage of the converter being correct, the machine may be connected to the load which it is desired to supply.—*July 29th*, 1926.

TRANSMISSION OF POWER.

255,673. September 10th, 1925.—IMPROVEMENTS IN OR RELATING TO THREE-PHASE ELECTRIC CABLES, Pirelli-General Cable Works, Ltd., and Robert Eustace Horley, of Western Shore, Southampton.

According to this invention each single core cable of a three-phase cable comprises a sector-shaped conductor provided with an insulation and a metal sheath, preferably a lead sheath, each of the insulated and metal-sheathed cores so formed having a section approximately that of a third segment of a circle. The three single-core cables can then be laid up together either with

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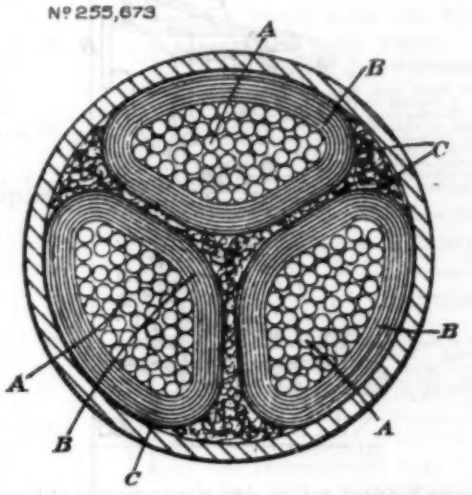

the metal sheaths in contact or separated by a light separating material, such as oiled paper, so as to form a circular three-conductor cable. This arrangement is illustrated in the accompanying drawing, in which the three cores comprise the stranded sector shaped conductors A, each surrounded by insulating material B and a lead sheath C. The whole may then be enclosed in an armour made of steel tapes or wires. Cables manufactured in the manner described possess all the advantages of single metal-sheathed cables laid up together, whilst at the same time the overall diameter of the complete cable is kept as small as possible.—*July 29th*, 1926.

FURNACES.

255,753. February 22nd, 1926.—ROTARY FURNACES, J. S. Atkinson and Stein and Atkinson, Ltd., 47, Victoria-street, Westminster.

This furnace is intended for firing Lancashire and similar boilers and is completely exterior to the boiler proper, with which it is connected by means of an extension A. It comprises a rotary cylinder after the fashion of a trommel, of which the

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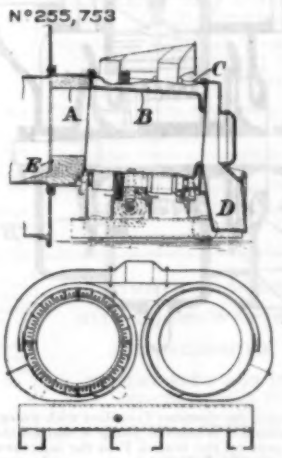


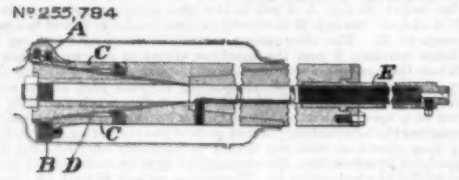
periphery is formed by a series of fire-bars B, while an exterior casing C provides an annular space for preheating the incoming air. The drum is set at a slight angle, as shown, so that the clinker tends to work down to the front and is collected in the hopper D. There is a dam E, set at the same angle as that of repose of the fuel, at the boiler end of the furnace. The fuel is led into the furnace tangentially.—*July 29th*, 1926.

MACHINE TOOLS AND SHOP APPLIANCES.

255,784. April 19th, 1926.—BORING BARS, Sir W. G. Armstrong, Whitworth and Co., Newcastle-on-Tyne, and F. W. Palmer, Wood-road, Whalley Range, Manchester.

This tool is intended for chambering out long-bore holes

where ordinarily there may be some difficulty in ensuring a parallel cutting action. The reaction of the cutter A is taken by a pair of pads, one of which is shown at B. In this connection it should be pointed out that the drawing is described as a sec-

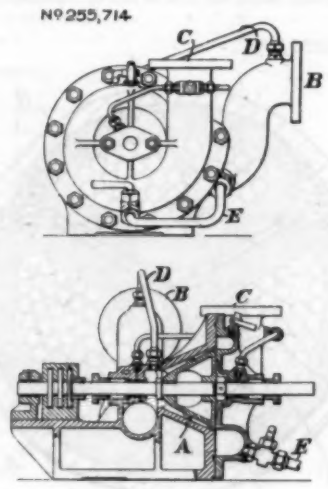


tional side elevation although the two pads and the cutter are spaced at equal distances apart round the circumference. The cutter and the pads, it will be seen, are mounted on hinged arms C C and the cut is put on by means of the cone D and the screw adjustment E.—*July 29th*, 1926.

PUMPING AND BLOWING MACHINERY.

255,714. December 15th, 1925.—ROTARY PUMPS, A. G. Mumford, Ltd., Colchester, and E. B. Tait, 229, Maldon-road, Colchester.

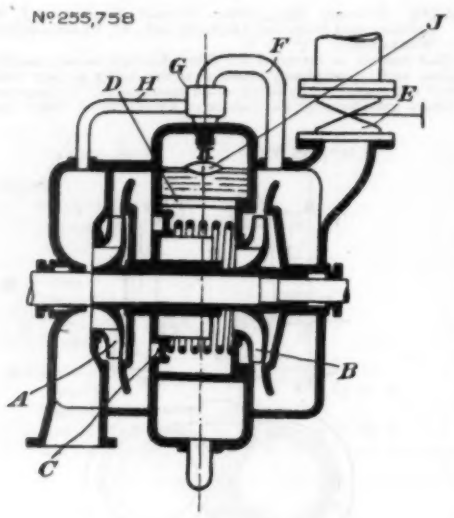
The impeller of this pump is a conical helix A and has an inlet at B, while C is the discharge branch. The inlet is curved upward, as shown, to entrap some water in the casing when the



pump is stopped, and this water is prevented from syphoning out by the connecting pipe D. The pipe E connects the discharge with the suction and by-passes sufficient of the entrapped water on starting up to seal the fine clearance between the helix and the casing and thus enable the pump to prime itself.—*July 29th*, 1926.

255,758. February 23rd, 1926.—SELF-PRIMING PUMPS, R. Hentschel, 69, Parkallee, Bremen, Germany.

This self-priming arrangement is put forward as being specially applicable to multi-stage centrifugal pumps. That shown in the illustration has two stages, with impellers at A and B. The first impeller A discharges through the non-return valve C into the chamber D and thence to the second impeller B. In order to

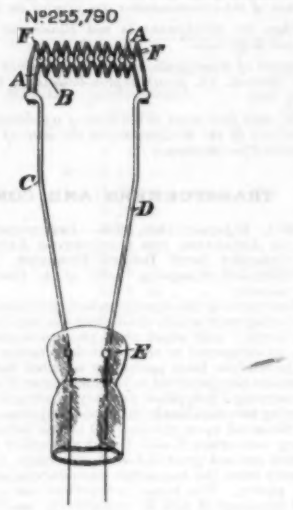


prime the pump the chamber D is filled with water and the outlet valve E is closed. When the pump is started the water in the chamber is sent up the branch F to the injector G and back to the chamber. The injector produces a suction through the branch H and creates a vacuum that fills the pump with water. When the impeller A gets its water the chamber D is filled and the float J shuts off the injector.—*July 29th*, 1926.

LIGHTING AND HEATING.

255,790. May 4th, 1926.—IMPROVEMENTS IN FILAMENTS FOR ELECTRIC INCANDESCENT LAMPS OR OTHER PURPOSES, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C. 2.

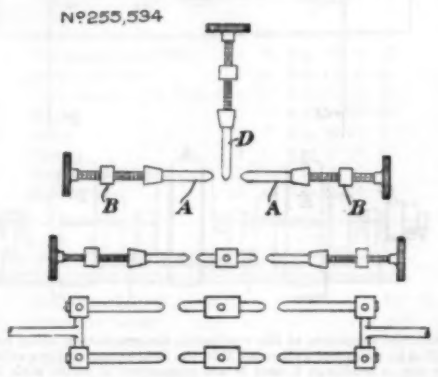
The drawing shows in side elevation a filament for electric incandescent lamps of high candle-power, constructed in accordance with this invention. The filament consists of two wire spirals A B wound in opposite directions, fitted into one another and secured between leading-in wires C D. The latter are fused into a glass pinch E, which, in its turn, is fused into the neck portion of the lamp bulb (not shown). The wire spirals A B cross each other twice in each turn and are riveted or welded



together at these points of intersection F. The joints at the points of intersection are made preferably by spot welding several at once. In place of the wire spiral, ribbon spirals may, of course, be used.—*July 29th*, 1926.

255,534. April 24th, 1925.—IMPROVEMENTS IN ELECTRIC ARC LAMPS, John Robert Quain, 17, Victoria-street, Westminster, S.W. 1.

This lamp is designed to use two or more arcs in series. A A represent the usual positive and negative electrodes carried by holders, B B represent bearings in which the adjusting

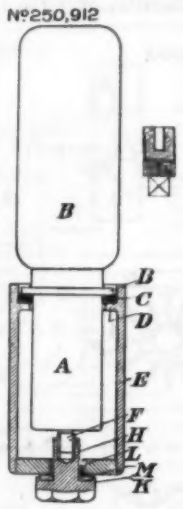


screws are supported, each screw being operated by its respective insulated knob. D represents the intervening electrode carried by a holder, this intervening electrode being adjusted or regulated by a knob and screw supported in a bearing. The alternative arrangements shown in the two lower illustrations are more or less self-explanatory, the latter representing an arrangement for burning four arcs in series.—*July 26th*, 1926.

MISCELLANEOUS.

250,912. March 8th, 1926.—IMPROVEMENTS IN OR RELATING TO ELECTRIC DISCHARGE TUBES, N. V. Philips' Gloeilampenfabrieken, Emmasingel 6, Eindhoven, Netherlands.

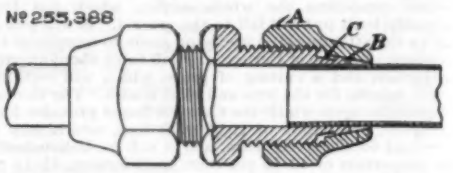
The transmission valve described in this specification has a cylindrical metal anode A which is sealed to a glass vessel B. At some distance from the seal the anode is provided with a flange, and a ring C of rubber or other packing material is pressed against an interior flange D of a cylindrical metal cooling



vessel E. This is done with the aid of a stud F fixed to the bottom of the anode A and of a nut H fitting around the stud and provided outside the cooling vessel with a head K. In the bottom of the cooling vessel E there is a hole L with an internal screw thread through which the nut H freely passes, but which has a smaller diameter than the head K, so that when the nut is screwed up, the outer edge of the head is pressed, with the interposition of a packing ring M, against the bottom of the vessel E. If the discharge tube has to be removed from the cooling vessel the nut H must be entirely unscrewed. It may, however, easily occur that the packing ring sticks fast to the flange so that it is desirable to exercise some pressure against the bottom of the metal anode, because it is not advisable to exert much force either on the glass envelope B or on the anode immediately below the seal. The necessary pressure may very easily be exercised by screwing a tap bolt into the plug hole. This bolt will then press against the stud F, or, if the tap bolt is provided with an axial bore of sufficient width, against the bottom of the anode A and will raise the flange from its seat. An example of the tap bolt is shown.—*July 29th*, 1926.

255,388. April 9th, 1926.—PIPE JOINTS, Manley and Regulus, Ltd., Birch-street, Wolverhampton, and P. J. Jemmett.

In this union a tight joint is made with the pipe by screwing



up the internally coned nut A, so that it squeezes the tapered end B on to the pipe. A groove is provided at C to make the end of the nipple resilient.—*July 22nd*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY AND SATURDAY, SEPTEMBER 3RD AND 4TH.

INSTITUTE OF METALS.—Autumn meeting at Liége. For programme, see pages 45 and 181.

SATURDAY, SEPTEMBER 4TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—North-Eastern District meeting at Blyth. 12.30 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—South Wales District meeting at Llantrysant and District. 10.55 a.m.

SATURDAY TO SATURDAY, SEPTEMBER 4TH TO 18TH.

NATIONAL RADIO EXHIBITION.—Olympia, London. W. 1. 10.30 a.m. each day.

MONDAY TO SATURDAY, SEPTEMBER 6TH TO 18TH.

UNIVERSAL SMOKE ABATEMENT EXHIBITION.—Bingley Hall, Birmingham.

FRIDAY, SEPTEMBER 10TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—North-Eastern District meeting at Middlesbrough. 2 p.m.

SATURDAY, SEPTEMBER 11TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Eastern District meeting at Great Yarmouth. 11 a.m.

MONDAY, SEPTEMBER 13TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Visit to the Salford Ironworks of Mather and Platt, Ltd.

TUESDAY, SEPTEMBER 14TH.

INSTITUTE OF MARINE ENGINEERS.—85-88, The Minories, Tower Hill, London, E. 1. Paper, "Steam Pipes for Super High Pressure," by Mr. J. A. Aiton. 6.30 p.m.

TUESDAY TO THURSDAY, SEPTEMBER 14TH TO 16TH.

INSTITUTION OF PUBLIC LIGHTING ENGINEERS.—Annual meeting and Conference at Newcastle-upon-Tyne. For programme see page 229.

SATURDAY, SEPTEMBER 18TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Meeting of North-Eastern and Yorkshire Districts at Whitby. 12 noon.

WEDNESDAY, OCTOBER 6TH.

INSTITUTION OF SANITARY ENGINEERS.—Caxton Hall, Westminster, London, S.W. 1. Reception and conversazione. Paper, "Housing Problems, with Special Reference to Subsidies and Rural Needs," by Mr. G. B. Chilvers. 6.30 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS: THE PORTLAND HOUSE SCHOLARSHIP.—The Institution of Structural Engineers has awarded the Portland House Scholarship, £300 and gold medal, to Mr. George Robertson, of Bath; a silver medal to Mr. C. J. Wood, of Purley; and a bronze medal to Mr. F. W. Davey, of Victoria-street, S.W., the two candidates placed next in order of merit.

INSTITUTION OF NAVAL ARCHITECTS.—The following scholarships have been awarded by the Council of the Institution of Naval Architects:—(*a*) Royal Commissioners for the 1851 Exhibition Post Graduate Research Scholarship in Naval Architecture (1926), £250 per annum, to Mr. F. H. Todd, B.Sc., of Armstrong College, Newcastle-on-Tyne; (*b*) Sir William White Post Graduate Research Scholarship (1926), £150 per annum, to Mr. Thomas W. F. Brown, B.Sc., of the Royal Technical College, Glasgow; and (*c*) Martell Scholarship in Naval Architecture (1926), £130 per annum, to Mr. J. H. Lamble, of Devonport Dockyard. The Earl of Durham Prize has been awarded to Mr. J. H. Mitchell, of Devonport Dockyard.